5-6115-339-12

TM 5-6115-339-12

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TECHNICAL MANUAL

OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL

GENERATOR SET, GAS TURBINE ENGINE: 60 KW, AC, 120/208, 240/416 V, 3 PHASE, 4 WIRE, SKID MOUNTED, WINTERIZED (AIRESEARCH MODEL GTGE 70-9-2)

FSN 6115-758-5492

This copy is a reprint which includes current pages from Changes 1 and 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY

OCTOBER 1971

D 101.11:

READEX FICHE best copy available

WARNING

Take particular heed to specific cautions and warnings throughout this manual.

HIGH VOLTAGE

is used in the operation of this equipment.

DEATH

or severe burns may result if personnel fail to observe safety precautions. Do not operate this generator set until the ground terminal stud has been connected to a suitable ground. Disconnect the battery ground cable before removing and installing components on engine or in electrical control panel system. Before making kilowatt load connections for parallel operation, be sure the generator sets are not operating and main circuit breakers are in the OFF position. Do not attempt to change load connects when generator is running. Before servicing any part of a generator set, make sure unit is completely deenergized.

DANGEROUS GASES

are generated as a result of operating of this equipment.

DEATH

or severe injury may result if personnel fail to observe safety precautions. Utilize extreme caution, do not smoke, or use open flame in vicinity when servicing batteries. Batteries generate explosive gas during charging. Always maintain metal to metal contact when filling the fuel tank. Do not smoke ur use open flame in vicinity when filling the fuel tank. Do not attempt to fill fuel tank when generator is running. Do not operate generator sets in inclosed areas unless exhaust gases are properly vented to the outside. Exhaust discharge contain noxious and deadly fumes. Use extreme care, should a selenium rectifier malfunction, to avoid inhalation of poisonous fumes.

LIQUIDS UNDER PRESSURE

are generated as a result of operation of this equipment.

INJURY

or severe burns may result if personnel fail to observe safety precautions.

CAUTION

DAMAGE

to the equipment may result if personnel fail to observe safety precautions. When removing one of two generator sets operating in parallel, insure the load on the service lines is not greater than the rating of the remaining unit. If generator set is shut-down by the operation of a safety device, do not attempt to operate unit until the cause has been determined and eliminated.

TM 5-6115-339-12
C 2

CHANGE
No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *12 December 1974*

Operator and Organizational Maintenance Manual
GENERATOR SET, GAS TURBINE ENGINE: 60 KW, AC, 120/208, 240/416V, 3-PHASE, 4-WIRE SKID MOUNTED, WINTERIZED (AIRESEARCH MODEL GTGE 70-9-2) FSN 6115-758-5492

TM 5-6115-319-12, 2 October 1971, is changed as follows:

Page 2 of Cover. Add the following warnings:
Before Operations.

WARNING

Do not rely on grounding or safety devices to prevent accidents. Electrical circuits and equipment are potentially hazardous. Personnel should always exercise caution to prevent injury or possible death due to electrical shock.
During Operations.

WARNING

Operations of this equipment presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional.
After Operations.

WARNING

Drycleaning solvent, Fed. spec. P-D-680, used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. The flash point of solvent is 100° F. (38° C.) - 138° F. (59° C.).

Page 1-1. Paragraph 1-4 is superseded as follows:

You can improve this manual by recommending improvements using DA Form 2028 (Recommended Changes to Publications and Blank Forms) and mailing the form to Commander, US Army Troop Support Command, ATTN: AMSTS-MPP, 4300 Goodfellow Boulevard, St. Louis, Missouri 63120. A reply will be furnished direct to you.

Page 2-4. Paragraph 2-2*b*(1) is superseded as follows:

CAUTION

Generator sets should be grounded in order to prevent shock due to defective insulation or external electrical faults. Poor grounding can endanger personnel, may damage equipment, and can create interference in communications or electronic circuits.

(1) *Grounding.* Install one of the following items as a grounding device:

(a) Drive a ground rod to a depth of at least 8 feet. This is the preferred device which is available in the Army supply system.

(b) Drive a ground pipe, ¾-inch, copper or steel, to a depth of at least 8 feet. An existing underground pipe may be used in an emergency.

(c) Bury a ¼-inch thick iron or steel plate, approximately 18-inch x 18-inch size with ground cable attached, to a depth of at least 4 feet.

(d) Bury a 1/16-inch thick aluminum or copper plate approximately 18-inch x 18-inch size with ground cable attached, to a depth of at least 4 feet.

(2) Saturate the area around the grounding device with water to increase conductivity.

(3) Connect the ground cable from the grounding device to the generator set frame ground terminal (fig. 1-1) and tighten the nut securely.

NOTE

Ground cables should be copper. Braided cable is the best, but No. 6 AWG gage (or larger) copper wire will suffice.

Page A-1. Paragraph A-1 is superseded as follows:

A-1. Fire Protection and Safety

TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved for Army Users.
TB MED 251	Noise and Conservative of Hearing.

By Order of the Secretary of the Army:

FRED C. WEYAND
General, United States Army
Chief of Staff

Official:
VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-25D (qty rqr block No. 769), Operator Requirements for Motor Generators, 60 KW.

GPO 902-495

Change No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, *27 September 1973*

Operator and Organizational Maintenance Manual
GENERATOR SET, GAS TURBINE ENGINE: 60 KW, AC, 120/208, 240/416V, 3 PHASE, 4 WIRE, SKID MOUNTED, WINTERIZED (AIRESEARCH MODEL GTGE 70-9-2) FSN 6115-758-5492

TM 5-6115-339-12, 2 October 1971, is changed as follows:

Page 1-1. Paragraphs 1-1, 1-2, and 1-4 are superseded as follows:

1-1. Scope

This manual is for your use in operating and maintaining the generator set, Airesearch Model GTGE 70-9-2.

1-2. Maintenance Forms and Records

Maintenance forms and records that you are required to use are explained in TM 38-750.

1-4. Reporting of Equipment Publication Improvements

The reporting of errors, omissions, and recommendations for improving this manual by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forward direct to Commander, US Army Troop Support Command, ATTN: AMSTS-MPP, St. Louis, MO 63120.

Paragraphs 1-5 and 1-6 are rescinded.

Page C-1. Appendix C is superseded as follows:

APPENDIX C
BASIC ISSUE ITEMS LIST AND ITEMS TROOP INSTALLED OR AUTHORIZED LIST

Section I. INTRODUCTION

1. Scope

This appendix lists items required by the operator for operation of the generator set.

2. General

This list is divided into the following sections:

a. Basic Issue Items List—Section II. Not applicable.

b. Items Troop Installed or Authorized List—Section III. A list of items in alphabetical sequence, which at the discretion of the unit commander may accompany the generator set. These items are NOT SUBJECT TO TURN-IN with the generator set when evacuated.

3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Basic Issue Items List, Section II, and Items Troop installed or Authorized List, Section III.

a. Source, Maintenance, and Recoverability Code(s) (SMR): (Not applicable).

b. Federal Stock Number. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the Federal item name and any additional description of the item required.

d. Unit of Measure (U/M). A two-character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. Quantity Furnished with Equipment (BIIL). Not applicable).

f. Quantity Authorized (Items Troop Installed or Authorized). This column indicates the quantity of the item authorized to be used with the equipment.

Section III. ITEMS TROOP INSTALLED OR AUTHORIZED LIST

(1) SMR code	(2) Federal stock number	(3) Description Ref. No. & Mfr code Usable on code	(4) Unit of meas	(5) Qty auth
	7520-559-9618	Case, Maintenance and Operational Manuals	EA	1
	4210-555-8837	Extinguisher, Fire	EA	1
	5975-878-3791	Rod Assembly, Ground	EA	1

By Order of the Secretaries of the Army and the Air Force:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

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Major General, United States Army
The Adjutant General

JOHN D. RYAN, *General, USAF*
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Director of Administration

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To be distributed in accordance with DA Form 12-25A (qty rqr block No. 181) operator maintenance requirements for Welding.

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TECHNICAL MANUAL
NO. 5-6115-339-12

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D. C., *2 October 1971*

OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL

GENERATOR SET, GAS TURBINE ENGINE:

60KW, AC, 120 / 208, 240 / 416V, 3 PHASE, 4 WIRE,

SKID MOUNTED, WINTERIZED

(AIRESEARCH MODEL GTGE 70-9-2)

FSN 6115-758-5492

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*** This manual supersedes TM 5-6115-339-12, 11 August 1966 including all changes.**

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual is for the use of operators and organizational maintenance personnel. Information on operating and maintaining the Airesearch Model GTGE 70-9-2 Generator Set is provided. Also included are descriptions of main units and their functions in relationship to other components.

1-2. Maintenance Forms and Records

Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

1-3. Equipment Serviceability Criteria (ESC)

This equipment is not covered by an ESC.

1-4. Reporting of Errors

Report of errors, omissions and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028, Recommended Changes to Publications, and forwarded direct to Commanding General, U. S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Blvd., St. Louis, Mo. 63120.

1-5. Destruction of Army Material to Prevent Enemy Use

For information pertaining to the destruction of this equipment to prevent enemy use, refer to TM 750-244-3.

1-6. Administrative Storage

For information relative to the administrative storage of this equipment, refer to TM 740-90-1.

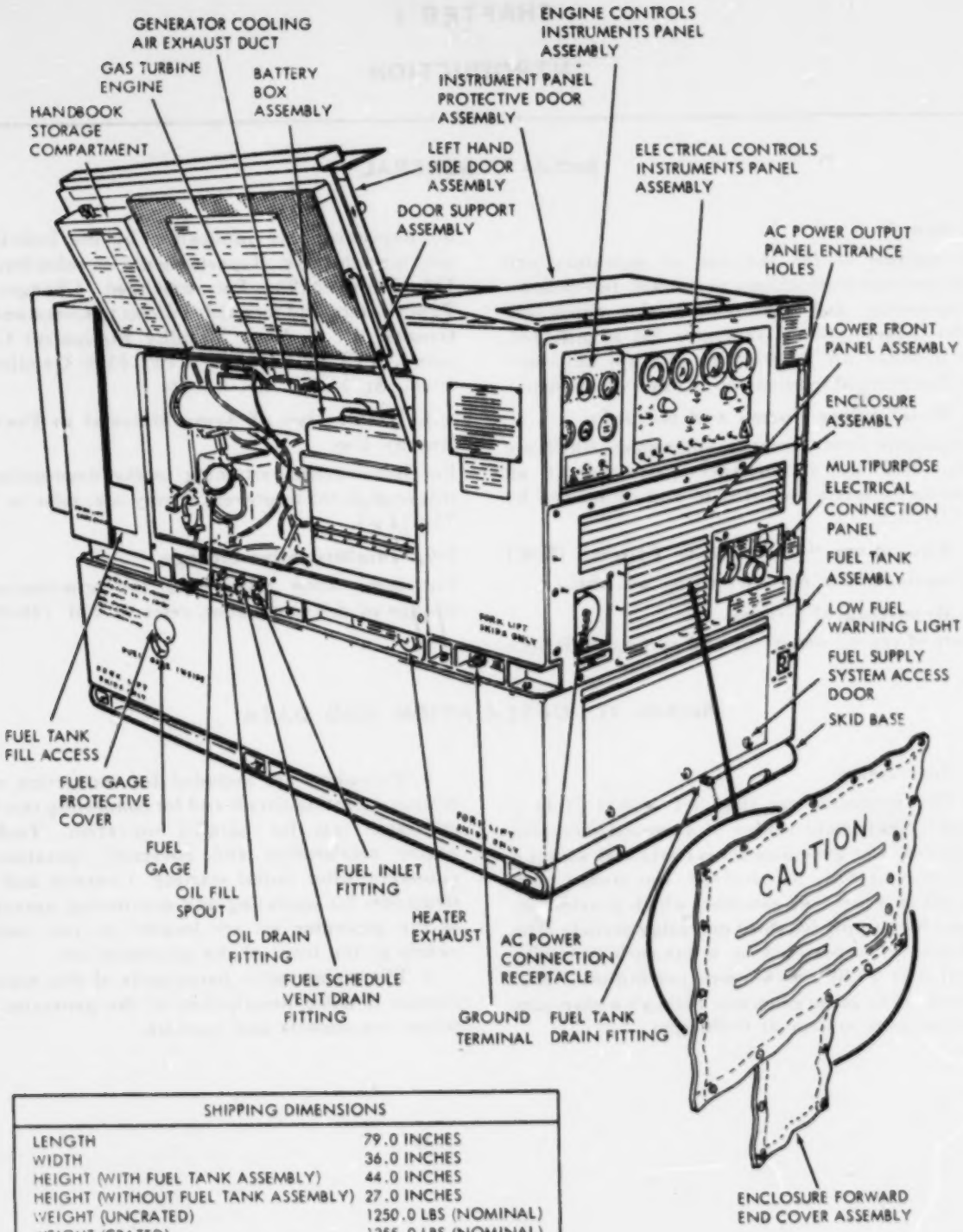
Section II. DESCRIPTION AND DATA

1-7. Description

a. The generator set (fig. 1-1 and 1-2) is a compact, lightweight source of alternating current (ac) power. The generator set is contained within a weather-resistant, winterized enclosure and mounted on a fuel tank assembly which provides an integral fuel supply for short operating periods. The generator set is powered by a gas turbine engine operating at 10,800 revolutions per minute (rpm) and coupled to an ac generator through a planetary reduction gear system at 6000 rpm.

b. Provisions are included for connection of a remote operating circuit and for connecting two like generator sets for parallel operation. Turbine engine acceleration and governed operation is automatic after initial starting. Controls and instruments for operating and monitoring operation of the generator set are located on two control panels at the front of the generator set.

c. The maintenance paragraphs of this manual contain detailed descriptions of the generator set major components and systems.



SHIPPING DIMENSIONS	
LENGTH	79.0 INCHES
WIDTH	36.0 INCHES
HEIGHT (WITH FUEL TANK ASSEMBLY)	44.0 INCHES
HEIGHT (WITHOUT FUEL TANK ASSEMBLY)	27.0 INCHES
WEIGHT (UNCRATED)	1250.0 LBS (NOMINAL)
WEIGHT (CRATED)	1355.0 LBS (NOMINAL)

ME 6115-339-12/1-1

Figure 1-1. Generator set, left-front, three-quarter view with shipping dimensions.

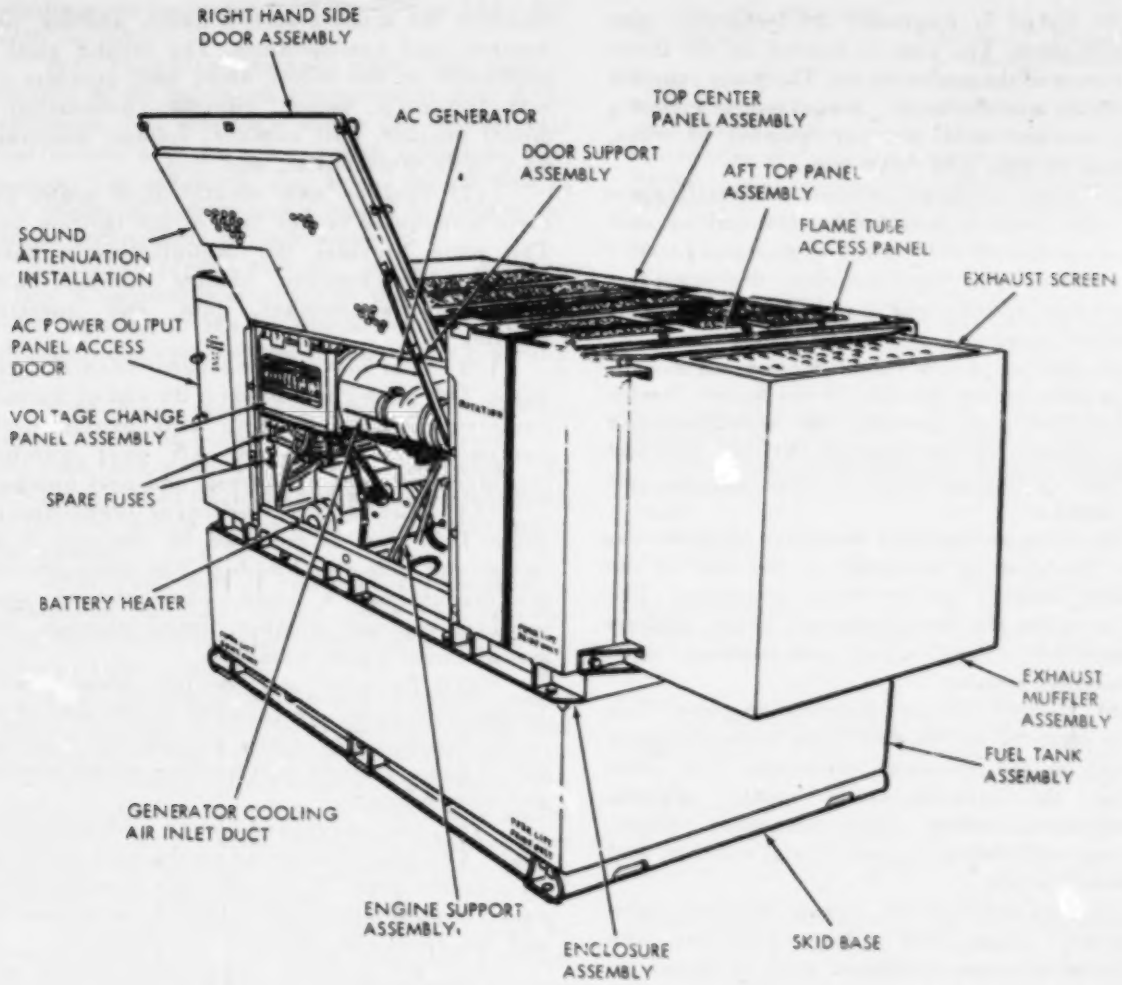


Figure 1-2. Generator set, right-rear, three-quarter view.

1-8. Difference in Models

This manual covers part number 13207E3830-1 model GTGE 70-9-2 generator set, serial numbers P-21551 through P-21560. Although part number 13207E3830-2, model GTGE 70-9-2 generator sets are not covered in this manual, the specific differences between part number 13207E3830-2 and part number 13207E8380-3 which are in the fuel vent system, are shown in the appropriate sections of this manual. The serial numbers for part number 13207E3830-2, model GTGE 70-9-2, are 21566 through 21633 and will retain the same serial numbers and model numbers after being modified into part number 13207E3830-3.

1-9. Tabulated Data

a. Identification. The generator set has 18 major identification plates and 10 major instruction plates. The information contained on these plates are listed below.

(1) *Corps of Engineer identification plates.* The two plates are located on the upper front corner of the left side of the generator. The top identification plate provides the electrical ratings, fuel requirement specifications, oil requirement specification, manufacturer's name and address, part number, series number, manufacturers model number, serial number, contract number, inspection data, weight, and Corps of Engineer model number. The lower identification plate provides the official nomenclature, stock number, serial number, manufacturer's name and model number, contract, number, data manufactured, shipping dimensions, shipping weight, engine manufacturer's name, engine model number, and engine serial number.

(2) *Corps of Engineers AC generator identification plate.* The plate is located on the lower front corner of the generator set. The plate provides the official nomenclature, manufacturer's name, model number, serial number, number of wires, electrical ratings, and drive rpm.

(3) *Gas turbine engine identification plate.* This plate is mounted on the ignition unit bracket on the left side of the engine compressor, inlet plenum. The plate provides the manufacturer's name, address, part number, series number, and model number.

(4) *Battery heater identification plate.* This plate is mounted on the side of the battery heater housing. The plate provides the manufacturer's name, address, model number, British Thermal Unit (btu) output, air output, voltage, ampere, and serial number.

(5) *Voltage regulator assembly identification plate.* This plate is mounted on the end of the regulator beneath the electrical connector. The plate provides the manufacturer's name, address nomenclature, voltage rating, part number, style, and contract number.

(6) *Battery charger identification plate.* This plate is mounted on the end of the battery charger adjacent to the electrical connector. The plate provides the manufacturer's name, address, nomenclature, voltage input, frequency, phase, amperage and voltage output, model number, and customer's name.

(7) *Contactor (main circuit breaker) identification plate.* This plate provides the manufacturer's name, address, type of contactor, part number, type of contacts, rating of contacts in amperes and volts, coil voltage, coil frequency, and coil rating. The plate is mounted on the side of the contactor.

(8) *Overcurrent sensing relay identification plate.* This plate is located on the side of the relay. The plate provides the manufacturer's name, address, part number, type of contacts, voltage, and frequency rating.

(9) *Main fuel pump and motor assembly identification plates.* These plates are mounted on top of the pump housing and motor housing respectively. The plates provide the manufacturer's name, address, motor part number, motor rating, amperes, rpm, volts, and motor frame number.

(10) *Auxiliary fuel pump and motor assembly identification plates.* These plates are mounted on top of the pump housing and motor housing respectively and provide the same information as (9) above.

(11) *Starter motor assembly identification plates.* Two plates are on the side of the motor housing. One plate is applicable to the complete starter motor assembly (motor and clutch) and provides the manufacturer's name, address, part number, and nomenclature. The second plate is applicable to the motor alone and provides the manufacturer's name, address, nomenclature, model number, part number, voltage, amperage, duty cycle, horsepower, and rpm.

(12) *Ignition unit identification plate.* This plate is mounted on the side of the ignition unit. The plate provides the manufacturer's name, address, part number, change number, order number, serial number, data, and operating warning.

(13) *Tachometer-generator identification plate.* This plate is mounted on the end of the tachometer-generator housing and provides the nomenclature, pole-type, AN part number, manufacturer's name, address, and part number.

(14) *Tachometer indicator identification plate.* This plate is mounted on the end of the tachometer indicator housing. The plate provides the manufacturer's name, nomenclature, stock number, contract number, serial number, and manufacturer's part number.

(15) *Tubular oil cooler identification plates.* Two plates are installed on the side of the cooler housing. The plates provide the manufacturer's name, address, part number, model number, and nomenclature.

(16) *Oil pressure gage identification plate.* This plate is mounted on the back end of the oil pressure gage. It provides the manufacturer's name, nomenclature, part number, serial number, and the applicable Military Specification.

(17) *Oil pressure sequencing switch identification plate.* This plate is located on the side of the switch and provides the manufacturer's name, address, type number, serial number, and order number.

(18) *Low oil pressure switch identification plate.* This plate is located on the side of the switch, and provides the manufacturers' name, address, part number, nomenclature, pressure rating, and serial number.

(19) *Engine lubrication instruction plate.* This plate is mounted on the oil tank assembly adjacent to the fill spout. The plate specifies recommended oil change periods, oil capacity, oil specification, and minimum starting temperature.

(20) *Operating instructions plate.* Located on the upper-right front of the generator set enclosure adjacent to the instrument panel protective door assembly. The plate provides the basic operating instructions for the generator set.

(21) *Voltage change panel instruction plate.* This plate is located on the voltage change panel access door and shows how ac generator

windings are connected for 120 / 208 or 240 / 416 volts output.

(22) *Plumbing schematic plate.* This plate is located on the handbook compartment door of the enclosure. The schematic shows the engine main fuel system and the winterization equipment fuel system. The schematic also shows the oil flow of the engine oil system and a legend to identify the major components of each system.

(23) *Control circuit wiring diagram plate.* This plate is mounted on the left hand side door adjacent to the handbook compartment. It shows the electrical control circuits of the generator set.

(24) *Fuel tank plumbing and electrical schematic label.* Located on the inside surf the fuel tank assembly control access door. The label provides an electrical and plumbing schematic of the fuel system with a legend to identify major components.

(25) *Fuel selector valve label.* This label is located on the fuel selector valve and provides pictorial and nomenclature identification of the fuel selector valve positions.

(26) *Auxiliary fuel pump priming switch label.* The label is located around the switch and provides operating instruction for the switch.

(27) *Auxiliary tank bleed air valve label.* The label is located on top of the auxiliary tank and is adjacent to the bleed air valve. The label provides operating instructions for the bleed air valve during auxiliary fuel pump priming.

(28) *Fuel drain valve label.* The label is located around the fuel drain valve and provides pictorial and nomenclature identification of the fuel drain valve position.

b. Tabulated Data.

(1) *Generator set.*

Manufacturer	Airesearch Mfg. Div. Phoenix, Arizona
Model	GTGE 70-9-2
Kilowatts	60
Kilovolt amperes	75
Fuel specification	JP3, JP4, and MIL-G-3056A, Type I and II
Fuel tank capacity	65 gallons
Oil specification	MIL-O-10295, MIL-L-2104, and MIL-L-7808
Oil tank capacity	1 quarts (qts)

(2) *Gas turbine engine.*

Manufacturer	Airesearch Mfg. Div., Phoenix, Arizona
Model	GTP 70-52
Full-load speed	10,800±100 rpm
No-load speed	10,800±100 rpm
Output shaft speed	6000 rpm
Compressor type	Two stage, centrifugal flow
Turbine type	Single stage, radial flow
Reduction gearing	Planetary
Operating oil pressure	90±10 psig
Electrical system	24v dc (negative ground)

(3) *AC generator.*

Manufacturer	General Electric Co. (alternate) Bendix Corp
Type	Brushless
Model (General Electric)	2CM355B2
Model (Bendix Corp)	28B190-1A
Operating speed	6000 rpm
Voltage	120 / 208, 240 / 416
Frequency	400 hertz per second (hps)
Phase	3
Power factor	0.80 (lagging)
Excitation	Self-excited
Type of connection	4-wire wye
Cooling	Blast air with internal fan

(4) *Voltage regulator assembly.*

Manufacturer	General Electric Co. (alternate) Bendix Corp.
Model (General Electric Co.)	352020BR129-B1
Model (Bendix Corp.)	20B105-1

(5) *Internal combustion battery heater.*

Manufacturer	Benmar Co.
Model	AP-2030
Type	Internal combustion
Output	20,000 btu / hr (British Thermal Units per hour)
Operating voltage	24 vdc
Operating power requirement	72 watts (w)
Fuel burning rate	11 to 13 cc / m (cubic centimeters per minute)
Fuel	Multifuel

(6) *Battery charger assembly.*

Manufacturer	General Motors Corp., Delco-Remy Div.
Model	110173
Type	Transformer-rectifier regulated
Input	120 vac, single phase, 400 hps
Output voltage	24 vdc (nominal) (adjustable 26 to 30 vdc regulated)
Output current	15 amps (max.)

(7) *Battery.*

Type	Lead-acid
Part number	MS35000-1
Ampere-hours	45
Voltage	24 vdc

(8) *Heater electric fuel pump.*

Manufacturer	Bendix Aviation Corp., Eclipse Machine Div.
Type	Pulsating
Voltage	24 vdc
Operating pressure	7.5 psig

(9) *Auxiliary and main fuel pumps and motor assemblies.*

Manufacturer	J.S. Barnes Co.
Model	GC-1212-A3
Type	Electrical motor driven rotary gear-type with internal bypass
Voltage	24 vdc
Current	1.8 amps
Discharge pressure	15.0 psig max (preset)
Flow rate	130 lbs / hr at 59° F (20 gal / hr)
Pump rpm	2000

(10) *Main fuel filter assembly.*

Manufacturer	AC Spark plug, Div. of General Motors Corp.

Type	Replaceable element
Part number	854924
Filtration rating	10 micron
Element service life	125 hrs (operating)

(11) *Fuel tank fuel filter and oil filter assemblies.*

Manufacturer	Military Standard MS28720-12
Element	Replaceable micronic line type
Filtration capacity	12 gpm
Element service life	125 hrs (operating)

(12) *Battery heater fuel filter assembly.*

Manufacturer	Bendix Corp.
Type	Reusable element
Part number	450-0
Filtration rating	10 micron
Element service life	125 hrs (operating)

(13) *Tabular oil cooler.*

Manufacturer	Airesearch Mfg. Div., Los Angeles, Calif.
Model number	OCTA100-41-1
Capacity	48° F differential between inlet and discharge oil temperature for 180 gal./hr.

(14) *Starter motor assembly.*

Manufacturer	Airesearch Mfg. Div., Los Angeles, Calif.
Motor model number	ACM40-B-1
Voltage	24 vdc
Current	135 amps
Horsepower	1.5
RPM	5000
Duty cycle	1 minute ON and 4 minutes OFF
Clutch slip torque	135 to 145 inch-pounds

(15) *Start relay.*

Manufacturer	Cutler Hammer Inc.
Model number	6042H152 (MS24142D2)
Type	4-pole, double throw
Nominal voltage rating	24 vdc
Actuating current	5 amps
Continuous current carrying capacity	200 amps
Maximum in-rush current	1200 amps

(16) *Ignition unit.*

Manufacturer	General Laboratory Associates Inc.
Part number	75425

(17) *Igniter plug.*

Manufacturer	Airesearch Mfg., Div., Phoenix, Arizona
Part number	75153

(18) *Battery electrolyte temperature sensor.*

Manufacturer	Airesearch Mfg. Div., Phoenix, Arizona
Part number	305164-1
Actuation (turn-on)	0° F
Deactuation (turn-off)	20° F

(19) *Voltmeter.*

Manufacturer	Weston Instruments and Electronics Div. of Daystrom Inc.
Part number	182324
Nominal input frequency	400 hps
Scale range	0 to 500 vac
Normal reading	Low voltage: 120 volts line-to-neutral; 208 volts line-to-neutral 416 volts line-to-neutral High voltage: 240 volts line-to-neutral; 416 volts line-to-neutral

(20) *AC ammeter.*

Manufacturer	Weston Instrument and Electronics Div. of Daystrom Inc.
Part number	196133
Scale range	0 to 135 percent of rated current
Normal reading	0 to 100 percent

(21) *Frequency meter and transducer (matched set).*

Manufacturer	Crydom Labs, Garden Grove, Calif. (alternate) Weston Instruments and Electronics Div. of Daystrom Inc.
Part number (Crydom Labs transducer)	CL393-1
Part number (Crydom Labs frequency meter)	CL393-2
Part number (Weston transducer)	182873
Part number (Weston frequency meter)	196999
Normal reading	400±1 hps

(22) *Wattmeter and thermal watt converter (matched set).*

Manufacturer	Weston Instruments and Electronics Div. of Daystrom Inc.
Part number (wattmeter)	196134
Part number (watt converter)	182871
Normal reading	0 to 60 kw

(23) *DC ammeter.*

Manufacturer	Weston Instruments and Electronics Div. of Daystrom Inc.
Part number	196910
Normal reading	+2 to +11 amps

(24) *Tachometer indicator.*

Manufacturer	Norden-Ketay Corp. (Military Specification MS2800-1)
Dial range	0 to 110 percent rpm
Normal reading	100±2 percent

(25) *Time totalizing meter.*

Manufacturer	Airesearch Mfg. Div., Phoenix, Arizona
Type	Direct reading
Recording range	0 to 999.9 hrs
Voltage range	24 to 38 vdc

(26) *Start counter.*

Manufacturer	Airesearch Mfg. Div., Phoenix, Arizona
Type	Direct reading
Maximum operating voltage	30 vdc
Pickup voltage	16 vdc (max)
Dropout voltage	10 vdc (min)
Recording range	0 to 9999 starts

(27) *Exhaust gas temperature gage.*

Manufacturer	Lewis Engineering Co.

Part number 149E31J
Normal readings ..... 1250° F max (during engine acceleration)
1310° F max (during steady-state, full-load engine operation)
1325° F max absolute

(28) *Oil pressure gage.*
Manufacturer ..... U.S. Gauge Co.
Part number ..... AW 1814AB06
Normal reading ..... 80 to 100 psig

(29) *Capacities.*
Lubrication system ..... 4 qts.
Fuel tank ..... 65 gallons

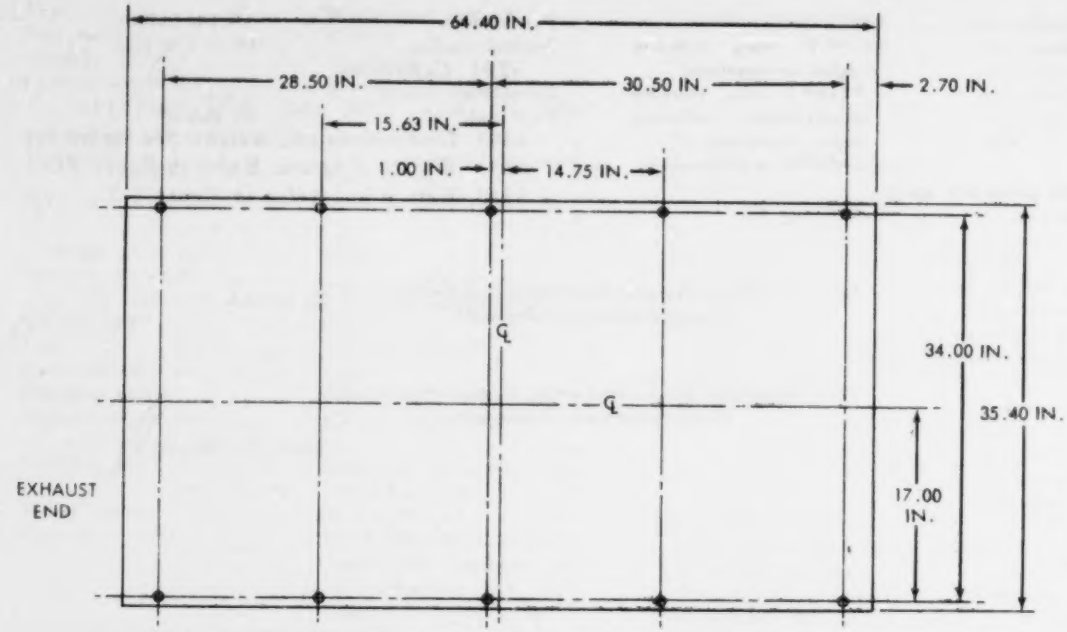
(30) *Dimensions and weight.* See figure 1-1.

(31) *Wiring diagram.* Refer to figure FO-1.

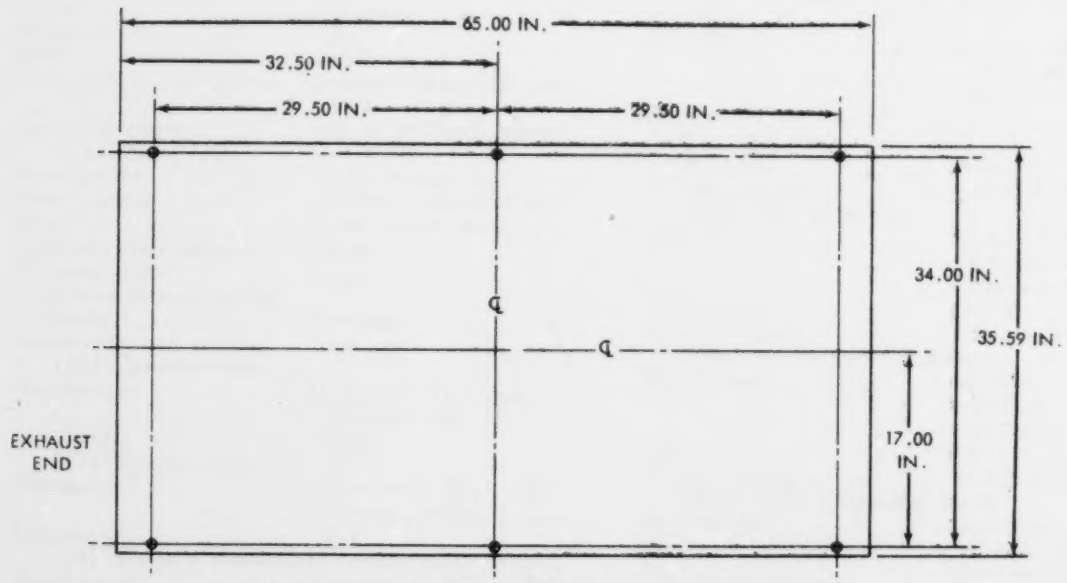
(32) *Base plan.* Refer to figure 1-3.

FO-1. Generator set practical wiring diagram (sheet 1 of 2).
(Located in back of manual).

FO-1. Generator set practical wiring diagram (sheet 2 of 2).
(Located in back of manual).



A. BASE PLAN OF GENERATOR SET WITH FUEL TANK ASSEMBLY REMOVED.



B. BASE PLAN OF GENERATOR SET WITH FUEL TANK ASSEMBLY INSTALLED.

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Figure 1-3. Generator set base plan.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF MATERIEL

2-1. Inspecting and Servicing Equipment

a. Inspection.

(1) Examine generator nameplate for positive identification of generator set.

(2) Insure all piping and tubing are secure and free from kinks, bends, cracks, or other damage.

(3) Insure that engine, engine accessories, ac generator, battery heater, and electrical components are securely mounted and undamaged.

(4) Perform daily preventive maintenance checks and services as described in paragraph 3-4.

b. Battery Servicing. The generator set batteries (fig. 2-1) are shipped installed, connected and dry. Service battery as follows:

(1) Insure that MASTER switch (on engine controls instrument panel) and WINTERIZATION HEATER switch (on electrical controls instrument panel) are in OFF position.

(2) Loosen wing nuts (fig. 2-1), remove battery box and cover assembly and lower battery box door assembly.

(3) Remove electrolyte temperature sensor and vent caps.

(4) Fill each battery cell with electrolyte until proper level is reached. If batteries do not have electrolyte markers, fill cells until electrolyte level is 3 / 8 inch above plates.

WARNING

If battery electrolyte is spilled on skin or clothing, immediately wash with cold water or a sodium bicarbonate solution to prevent severe skin burns or damage to clothing.

CAUTION

Avoid spilling battery electrolyte on painted surfaces. Damage to the painted surface may result.

(5) Check specific gravity of electrolyte in each battery cell with a hydrometer. Refer to TM 9-6140-200-15 for specific gravity temperatures corrections and to establish the state of battery charge with specific gravity corrected to 80°F.

NOTE

Low charge batteries may be charged by connecting an external battery charger at 24 VDC SLAVE RECEPTACLE J15.

CAUTION

When connecting an external dc power source to the 24V DC SLAVE RECEPTACLE J15, be sure that polarity of power source corresponds to polarity markings on J15. Failure to do so will result in damage to the generator set.

(6) Check that vent holes in battery vent caps (fig. 2-1) and electrolyte temperature sensor are open. Install battery vent caps and electrolyte temperature sensor. Connect electrolyte temperature sensor connector P17 securely to the sensor.

NOTE

Make sure connection between sensor and P17 is free of grease, dirt, and corrosion.

(7) Raise battery box door and install battery box cover in reverse order of removal.

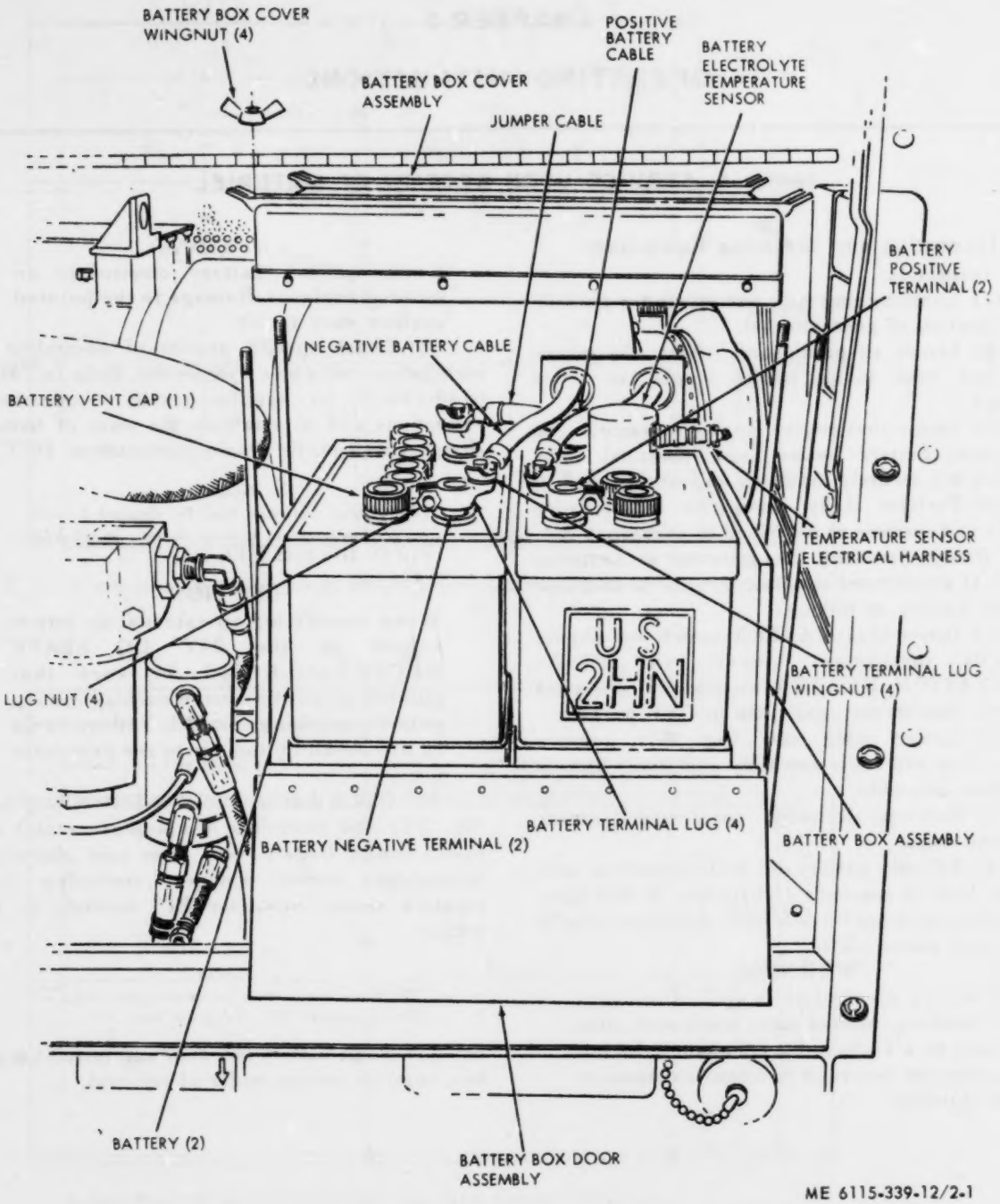

Figure 2-1. Battery installation.

c. Depreservation.

(1) Remove cap from oil drain fitting (fig. 2-2) and install a drain line. Extend drain line into suitable container. Open oil drain valve and allow preservative oil to drain into container.

(2) Close oil drain valve when preservative oil has drained, remove drain line, and install cap on oil drain fitting. Add lubricating oil to oil tank in accordance with LO 5-6115-339-12.

(3) Remove cap from fuel drain fitting and install a drain line. Extend drain line into a suitable container. Open fuel drain valve and allow any water or other residue to drain into container.

(4) Close fuel drain valve when tank has drained, remove drain line, and install cap on fuel drain fitting.

(5) Perform fuel system priming procedures (fig. 2-6).

(6) Refer to figure 2-7 and start the generator set. Operate at no load for 5 minutes and stop generator set as described in paragraph 2-10.

(7) Service oil filter and oil tank screen (fig. 3-1), fuel tank filter and fuel tank strainer (fig. 3-2), main fuel filter, and fuel control unit fuel filter (fig. 4-15).

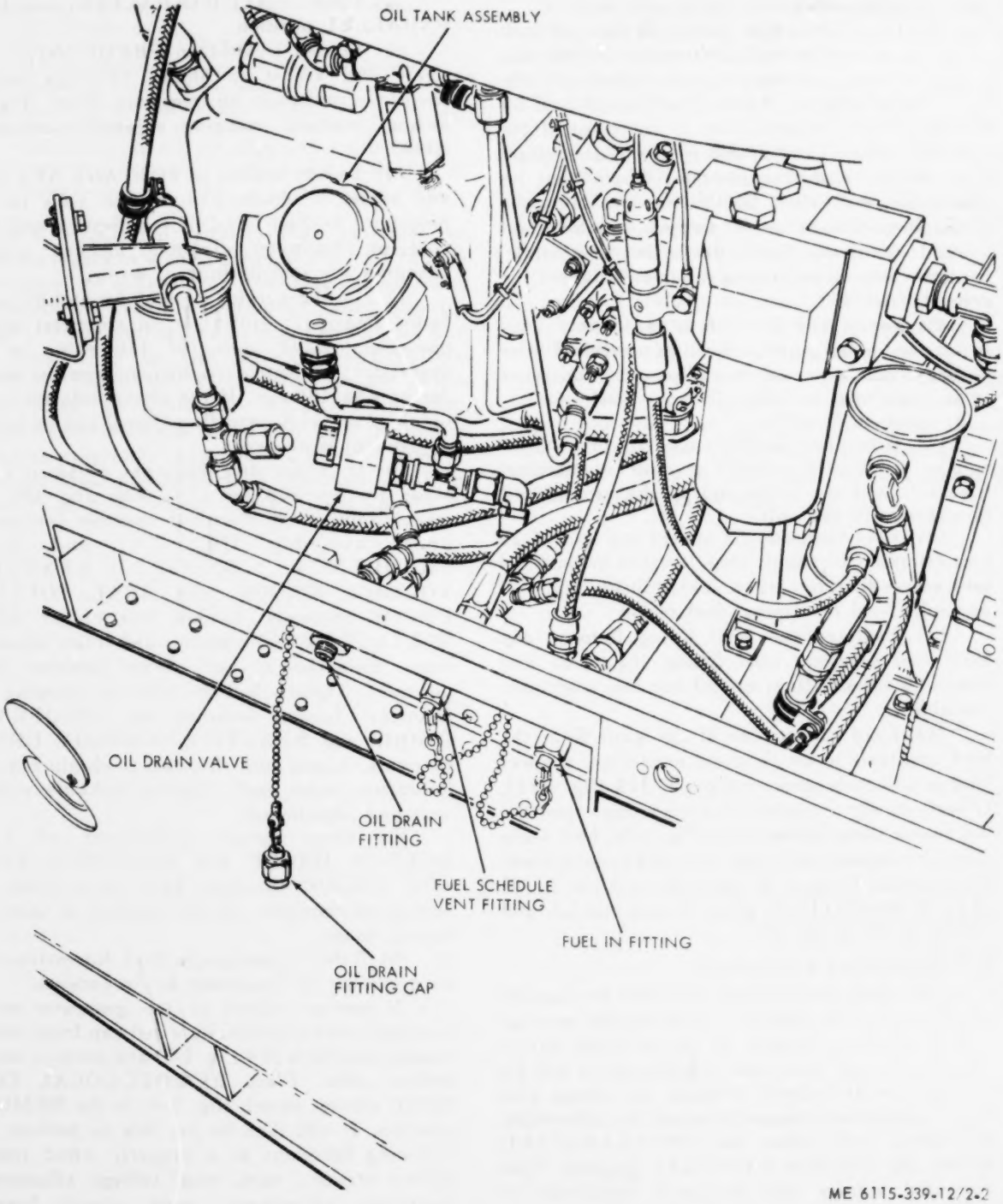

Figure 2-2. Oil drain valve, oil drain, fuel schedule vent, and fuel in fitting.

2-2. Installation

a. Location.

(1) Locations where generator set may be exposed to high humidity, sand, or dust should be avoided whenever possible. Moisture condenses on generator parts and electrical controls and may cause corrosion. Corrosion can seriously affect operation and efficiency of generator set.

(2) Locate set where there is at least 30 inch clearance on the left-hand side (service access); this clearance is also advisable for the right-hand side but is not mandatory. There should be at least 30 inches of unobstructed space at the front of the unit. The exhaust end should not be located closer than 4 feet to any obstruction. Insure that no obstruction will deflect the exhaust back into the intake louvers in the lower front panel. A sufficient amount of exhaust fumes drawn into the intake louvers will cause erratic operation or failure of the generator set.

(3) Locate the unit on a reasonably level surface and make the set as level as possible. Under no circumstances should the equipment be operated at an angle that exceeds 15° from level.

b. Outdoor Installation.

(1) *Grounding.* Connect one end of a No. 4 wire to the AC-DC exterior ground E-1 terminal (fig. 4-2) and the other end to the ground rod furnished with the unit.

(2) *Fuel connection.* Connect one end of 25 foot external fuel supply hose (located behind fuel tank access door, fig. 1-2) to fuel in fitting (fig. 2-2) and other end to external fuel supply.

(3) *Fuel schedule vent fitting.* Remove cap from fuel schedule vent fitting (fig. 2-2) and connect a suitable line; extend line into a suitable container.

(4) *Load connections.* If the leads from the load terminate in an electrical connector, connect load at 400 cycle power receptacle J18 (fig. 4-11). If leads do not terminate in a connector, open the AC power panel access door (fig. 1-2), feed leads through entrance holes (fig. 1-1), and connect them to terminals. Connect A phase to terminal L1, B phase to terminal L2, C phase to terminal L3, and neutral to Terminal LO.

2-3. Equipment Conversion

a. The equipment can be converted for parallel operation, remote operation, and remote sensing.

b. If parallel operation of two or more sets is required for any particular application, it will be necessary to deliberately increase the voltage and speed regulation by means of certain controls which are active only when the UNIT-PARALLEL switch (fig. 2-4) is in PARALLEL position. This increased voltage and frequency regulation is necessary to insure that the generator sets operated in parallel will share system load approximately equally. Prior to operating generator sets in parallel make certain steps 1 through 7 below are performed on each set.

(1) Refer to paragraph 2-9 and start generator set; allow set to warm up for approximately 15 minutes.

(2) Place UNIT-PARRALLEL switch in PARALLEL position.

(3) Loosen locknut on FREQUENCY ADJ screw and adjust to obtain 412 cps no-load frequency indication on frequency meter. Tighten locknut without changing adjusted position of screw.

(4) Loosen locknut on VOLTAGE ADJ screw and adjust to obtain 219 or 438 volts (as appropriate) no-load line-to-line indication (AB-BC-CA) on voltmeter. Tighten locknut without changing adjusted position of screw.

(5) Load generator set to 60 kw at 0.80 power factor (lagging); indication on voltmeter should decrease to 208 volts (or 416 volts, as appropriate); indication on frequency meter should decrease to 400 cps. If the above indications are obtained the set is correctly adjusted and no further adjustment is needed.

(6) If voltage and frequency obtained under loads are not 208 (or 416) volts and 400 cps, respectively, open electrical controls instrument panel assembly (fig. 1-1) and locate FREQUENCY DROOP, REACTIVE VOLTAGE DROOP, and REAL VOLTAGE DROOP rheostats. Loosen locknut on REAL VOLTAGE DROOP rheostat and rotate adjusting screw clockwise to zero droop position (lock position). Tighten locknut without charging adjustment. Loosen locknuts on FREQUENCY DROOP and REACTIVE VOLTAGE DROOP rheostats. Adjust both rheostats to obtain required indication under load. Tighten locknuts without changing adjustments.

(7) Once correct adjustment of FREQUENCY DROOP and REACTIVE VOLTAGE DROOP rheostats have been made, no further adjustments will be required of them for normal usage.

(8) Refer to paragraph 2-11 for instructions on operating the generator set in parallel.

c. If remote control of the generator set is required, remove internally wired cap from remote control receptacle J14 (fig. 2-3) and connect remote control cable. Place REMOTE-LOCAL CONTROL selector switch (fig. 2-4) in the REMOTE position. It will then be possible to perform the following functions at a properly wired remote control station; start, stop, voltage adjustment, frequency adjustment, main circuit breaker

operation, and monitoring of voltage and frequency.

NOTE

If the generator set controls are set for remote operation, and the remote control station is not connected, the generator set will not start. If the remote control station is inadvertently disconnected while the set is in operation, the generator set will shut down.

NOTE

The remote sensing circuit is normally disconnected by removal of an electrical lead from the back of the REMOTE SENSING-LOCAL SENSING VOLTAGE selector switch to prevent accidental connecting the switch to the REMOTE SENSING function during local sensing operation.

d. If application requires that generator set voltage regulator sense voltage at the load (due to excessive line voltage drop from load cables), open the electrical controls instrument panel assembly (fig. 1-1) and connect the wrapped and tagged lead to terminal 3 on the REMOTE SENSING-LOCAL SENSING VOLTAGE selector switch and place the switch in REMOTE position. Remove the internally wired plug from the remote control receptacle J14 (fig. 2-3) and connect voltage sensing leads from load through pins P, S, and R in J14. These voltage leads should be brought to the generator set through a connector which mates with J14 and has shorting connections between pins K and U, G and T, and H and N, if local control and remote sensing are employed simultaneously. If remote control and remote sensing are employed simultaneously, remote sensing leads will be provided in the remote cable.

e. If the generator set is connected for high voltage output (240 / 416 volts), a three-phase stepdown transformer (2:1 ratio) must be located in the remote sensing lead circuit to provide 120 / 208 volts at pins P, S, and R of J14.

CAUTION

If REMOTE SENSING-LOCAL SENSING VOLTAGE selector switch is placed in REMOTE SENSING position without having remote sensing leads connected to the load, an overvoltage condition will occur when the main circuit breaker is closed. This will cause loss of excitation and may possibly damage the load equipment.

f. After completion of operation requiring remote sensing, place switch in LOCAL position. Open the electrical controls instrument panel assembly and disconnect lead from terminal 3 of the switch. Wrap the lead with electrical tape and replace identification tag.

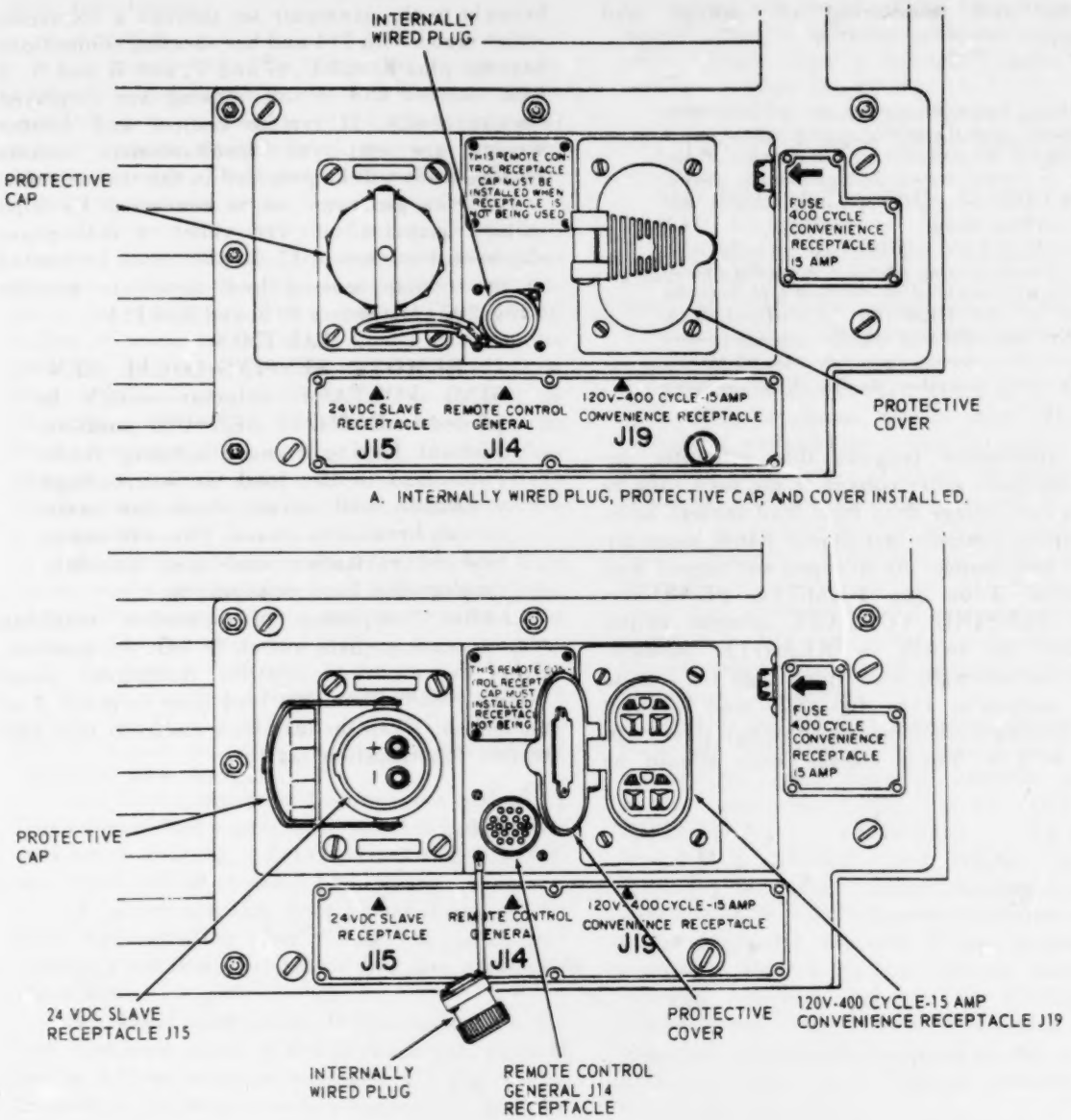
INTERNALLY WIRED PLUG
PROTECTIVE CAP
THIS REMOTE CONTROL RECEPTACLE CAP MUST BE INSTALLED WHEN RECEPTACLE IS NOT BEING USED
FUSE 400 CYCLE CONVENIENCE RECEPTACLE 15 AMP
24 VDC SLAVE RECEPTACLE J15
REMOTE CONTROL GENERAL J14
120V-400 CYCLE-15 AMP CONVENIENCE RECEPTACLE J19
PROTECTIVE COVER
A. INTERNALLY WIRED PLUG, PROTECTIVE CAP, AND COVER INSTALLED.
PROTECTIVE CAP
24 VDC SLAVE RECEPTACLE J15
INTERNALLY WIRED PLUG
REMOTE CONTROL GENERAL J14 RECEPTACLE
PROTECTIVE COVER
120V-400 CYCLE-15 AMP CONVENIENCE RECEPTACLE J19
B. INTERNALLY WIRED PLUG, PROTECTIVE CAP, AND COVER REMOVED.
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Figure 2-3. Electrical connections panel.

Section II. MOVEMENT TO A NEW WORKSITE

2-4. Dismantling for Movement

a. Disconnection.

(1) Remove all connections in reverse order of that described in paragraphs 2-1 and 2-2. Drain all fluids into suitable containers, replace and secure all caps and plugs.

(2) Loosen wing nuts (fig. 2-1) and remove battery box cover assembly. Lower battery box door.

(3) Disconnect positive battery cable and insulate cable lug with electrical tape. Wedge the taped lug securely in battery box in such a manner that it will not contact the battery terminal. the lug securely in place with electrical tape.

(4) Raise battery box door into position and install battery box cover in reverse order of removal.

(5) Close and secure instrument panel protective door assembly (fig. 1-1). Install enclosure cover assembly.

(6) Close and secure all access panels and doors of generator set enclosure.

b. Methods of Transportation. The generator set may be transported by standard carrier, cargo plane, or helicopter carrier.

NOTE

The enclosure assembly is weather resistant and normally need not be crated for shipment.

2-5. Reinstallation After Movement

a. Service batteries as described in paragraph 2-1.

b. Reinstall generator set as described in paragraph 2-2.

c. Perform daily preventive maintenance checks and services as described in paragraph 3-4.

Section III. CONTROLS AND INSTRUMENTS

2-6. General

This section describes, locates, illustrate and furnishes the operator, crew, or organizational maintenance personnel sufficient information about the various controls and instruments for proper operation of the generator set.

2-7. Controls and Instruments (fig. 2-4)

a. Oil Pressure Gage.

(1) *Description.* Dial pointer gage, calibrated to indicate 0 to 200 psig in 10 psig increments.

(2) *Purpose.* To indicate engine oil pressure during operation of generator set.

(3) *Indication.* Oil pressure of 80 to 100 psig during normal operation

b. Tachometer Indicator.

(1) *Description.* Dial pointer gage, calibrated to indicate 0 to 100 percent rpm in 2 percent increments. The large dial indicates in percent, and small dial indicates in tenths of percent.

(2) *Purpose.* To monitor engine rpm during operation.

(3) *Indication.* Normal rpm indications are: 10 to 15 percent for ignition to occur; 50 to 100 percent indicates oil pressure is increasing and should be 50 to 100 psig; 95 to 100 percent indicates that generator set is ready for load application.

c. Battery Charging Ammeter.

(1) *Description.* Dial pointer gage, calibrated to indicate —10 to +20 amperes in 1 ampere increments. Scale is colored red from —10 to 0 and green from 0 to +20.

(2) *Pupose.* To indicate battery charging current during operation.

(3) *Indication.* Battery charging current of about +11 amperes after initial engine start, charging current of +2 to +5 amperes after 2 hours of operation.

d. Start Counter.

NOTE

Upon failure or malfunction of the start counter, do not replace or repair. Disconnect electrical leads, insulate terminals and tie leads back to a suitable location.

(1) *Description.* A non-resetable, four-digit, single additive recording counter.

(2) *Purpose.* To record the total number of engine starts to serve as a guide for maintenance intervals.

(3) *Indication.* Indicates 0 through 9,999 engine starts. Unit column digits (extreme right) records in even numbers only; an odd number is indicated when the counter stops between two even numbers.

e. Exhaust Gas Temperature Indicator.

(1) *Description.* Dial pointer gage, calibrated to indicate 0° to 1800°F in 100° increments up to 900°F., 50° increments from 900°F to 1500°F., from 0° to 1310°F and red from 1310°F to 1800°F.

(2) *Purpose.* To indicate the exhaust gas temperatures in engine exhaust pipe during operation.

(3) *Indication.* Exhaust gas temperature

must not exceed 1250°F during engine acceleration or 1310°F during steady-state operation at full load.

f. Time Totalizing Meter.

(1) *Description.* A five-digit time totalizer counter.

(2) *Purpose.* To record the engine operating periods.

(3) *Indication.* The counter digits indicate total operating time in hours and tenths of hours since the last resetting of the dials. The meter begins recording operating time when engine rpm reaches approximately 95 percent of governed speed and continues until engine shutdown.

g. AC Ammeter.

(1) *Description.* Dial pointer gage, calibrated to indicate percent of rated amperes. The dial is calibrated from 0 to 125 percent in 5 percent increments. The dial range is color coded red from 100 to 125 percent.

(2) *Purpose.* To indicate line current of all phases, as selected through VOLT-AMP SELECTOR switch during operation.

(3) *Indication.* Normal range is 0 to 100 percent. Indications over 100 percent indicate an overload condition.

h. Synchronizing Lights.

(1) *Description.* Filament type panel lamps.

(2) *Purpose.* Indicates electrical synchronization between two generator sets when sets are adjusted for parallel operation.

(3) *Indication.* The synchronized point is established when the lamps are extinguished.

i. Voltmeter.

(1) *Description.* Dial pointer gage, calibrated to indicate 0 to 500V ac in 5 volt increments. The dial scale has red index marks at the 120, 208, 240, and 416 volt points.

(2) *Purpose.* Indicates line-to-line and line-to-neutral voltages as selected by the VOLT-AMP SELECTOR switch during operation.

(3) *Indication.* Indicates 120, 208, 240, or 416V ac as determined by the position of the VOLT-AMP SELECTOR switch and voltage change panel assembly.

j. Voltage Adjust Screw.

(1) *Description.* A slotted-head adjustment screw with locking nut.

(2) *Purpose.* Used to adjust the output voltage of the ac generator during operation of the generator set.

(3) *Adjustment.* Clockwise adjustment increases the voltage and counterclockwise decreases the voltage.

k. Frequency Meter.

(1) *Description.* Dial pointer gage, calibrated to indicate 388 to 412 cps in ½ cps increments. The dial scale has a red index mark at 400 cps.

(2) *Purpose.* To indicate the operating frequency of the ac generator during operation of the set.

(3) *Indication.* Normal indication is 400 ± 1 cps.

l. Wattmeter.

(1) *Description.* Dial pointer gage, calibrated to indicate 0 to 75 kilowatts in 5 kilowatt increments. The dial scale is colored red from 60 to 75 kilowatts.

(2) *Purpose.* Indicates output power of ac generator during operation.

(3) *Indication.* Normal operating range of 0 to 60 kilowatts. A reading in excess of 60 kilowatts indicates an overload condition.

m. Protection Bypass Switch.

(1) *Description.* A two position on-off toggle switch. A red lockout guard is installed over the switch to prevent accidental actuation.

(2) *Purpose.* Used in emergencies to bypass protective devices (except overspeed and short circuit) on the generator set.

WARNING

The protection bypass switch must be in the off position, with the red lockout guard in the closed (down) position. It should be used only in extreme emergencies when need for continued operation justifies risk incurred in loss of equipment and / or possible injury to personnel.

n. Unit-Parallel Selector Switch.

(1) *Description.* A two position rotary switch.

(2) *Purpose.* Provides for the activation of paralleling control circuit when in PARALLEL position. When set to UNIT position, switch deactivates paralleling control circuits, and connects the generator set for single unit operation.

o. Winterization Heater Switch.

(1) *Description.* A two position on-off toggle switch.

(2) *Purpose.* Provides control of 24v dc power to battery heater and the battery electrolyte temperature sensor. When placed in ON position and the manual heater fuel shut-off valve is open, heater operation is automatically controlled by the battery electrolyte temperature sensor to heat the batteries during extremely cold ambient temperatures.

p. Winterization Heater Lamp.

(1) *Description.* A filament type press-to-test lamp with amber lens.

(2) *Purpose.* Illuminates to indicate that battery heater is operating.

q. Winterization Heater Circuit Breaker.

(1) *Description.* A press-to-reset circuit breaker button installed in the battery heater electrical supply circuit.

(2) *Purpose.* Provide short circuit protection for battery heater circuits. Circuit breaker opening amperage (15 amps) is marked on reset button.

r. Main Circuit Breaker Closure Lamp.

(1) *Description.* A filament type press-to-test lamp with a green lens.

(2) *Purpose.* Illuminates to indicate that main circuit breaker is closed and 400 hps power is available at the ac outputs of the set. The illumination level of the lamp may be regulated during blackout conditions by turning the lens cap.

s. Main Circuit Breaker Switch.

(1) *Description.* A three-position toggle switch, spring-loaded to the center position.

(2) *Purpose.* Provides local control of main circuit breaker to connect (CLOSE) and disconnect (OPEN) electrical loads to ac generator outputs.

t. Overvoltage Lamp.

(1) *Description.* A filament type press-to-test lamp with amber lens.

(2) *Purpose.* Indicates when overvoltage relay has operated due to an overvoltage condition of ac generator. Lamp lights when overvoltage relay operates.

u. Over Volt Reset Switch.

(1) *Description.* A normally closed, two-position spring-loaded toggle switch.

(2) *Purpose.* To reset overvoltage protection circuits and permit recovery of excitation, after cause of overvoltage has been determined and corrected. Momentary actuation of switch to the up position resets the overvoltage protection circuits.

v. Frequency Adjust Screw.

(1) *Description.* A slotted-head adjustment screw with locking nut.

(2) *Purpose.* To provide adjustment of generator output frequency. Frequency changes resulting from adjusting screw clockwise (INCREASE) or counterclockwise (DECREASE) are monitored on the frequency meter.

w. Panel Lights Switch.

(1) *Description.* A two-position on-off toggle switch.

(2) *Purpose.* To control the 24 v dc power to the panel illumination lamps.

x. Remote-Local Control Selector Switch.

(1) *Description.* A two-position self-locking toggle switch.

(2) *Purpose.* Transfers control circuits from unit control panel to a remotely located control panel the remote control receptacle J14 (fig. 2-3), and remote control panel cable connection. Toggle must be pulled out to move switch from REMOTE or LOCAL position.

y. Remote-Local Voltage Sensing Selector Switch.

(1) *Description.* A two-position self-locking toggle switch.

(2) *Purpose.* Transfers ac generator voltage regulator voltage sensing circuit from internal sensing (LOCAL SENSING) to external sensing (REMOTE SENSING). Toggle switch must be pulled out to move switch from LOCAL or REMOTE SENSING position. Remote voltage sensing is employed to hold steady-state voltage constant at load in spite of large voltage drops in connecting cables.

CAUTION

The voltage regulator assembly is designed to operate on 120/208 volt system. If remote sensing is used when the generator set is operated on the high voltage output (416 volts line-to-line) a two to one stepdown transformer must be installed in the voltage sensing leads to prevent damage to voltage regulator components and to insure that the voltage regulator will hold the voltage at the desired value.

z. Volt-Amp Selector Switch.

(1) *Description.* A four position rotary switch.

(2) *Purpose.* Connects the ac ammeter and voltmeter for selective monitoring of the three line-to-line voltages, three line currents, and one line-to-neutral voltage during operation. When switch is placed in A-B, B-C, or C-A position, line currents and line-to-line voltages are monitored. Voltage from line-to-neutral is monitored when switch is in C-N position.

aa. Master Switch.

(1) *Description.* A three-position toggle switch, spring-loaded return from up position (START) to center position (RUN).

(2) *Purpose.* Functions to energize the engine power circuit and provide a momentary start circuit until appropriate holding relays are energized to automatically complete the starting sequence. The switch also functions as an engine stop switch by de-energizing the engine 24 v dc power circuit when set in OFF position.

ab. Internal DC Circuit Breaker Reset Button.

(1) *Description.* A button for a press-to-reset circuit breaker installed to protect all internal dc control circuits.

(2) *Purpose.* Provides protection for the internal dc control circuits.

ac. Battery Charger Input Circuit Breaker Reset Button.

(1) *Description.* A button for a press-to-reset circuit breaker installed to protect the battery charger input circuit.

(2) *Purpose.* Provides overload protection for 120 v ac input (line-to-neutral) to battery charger.

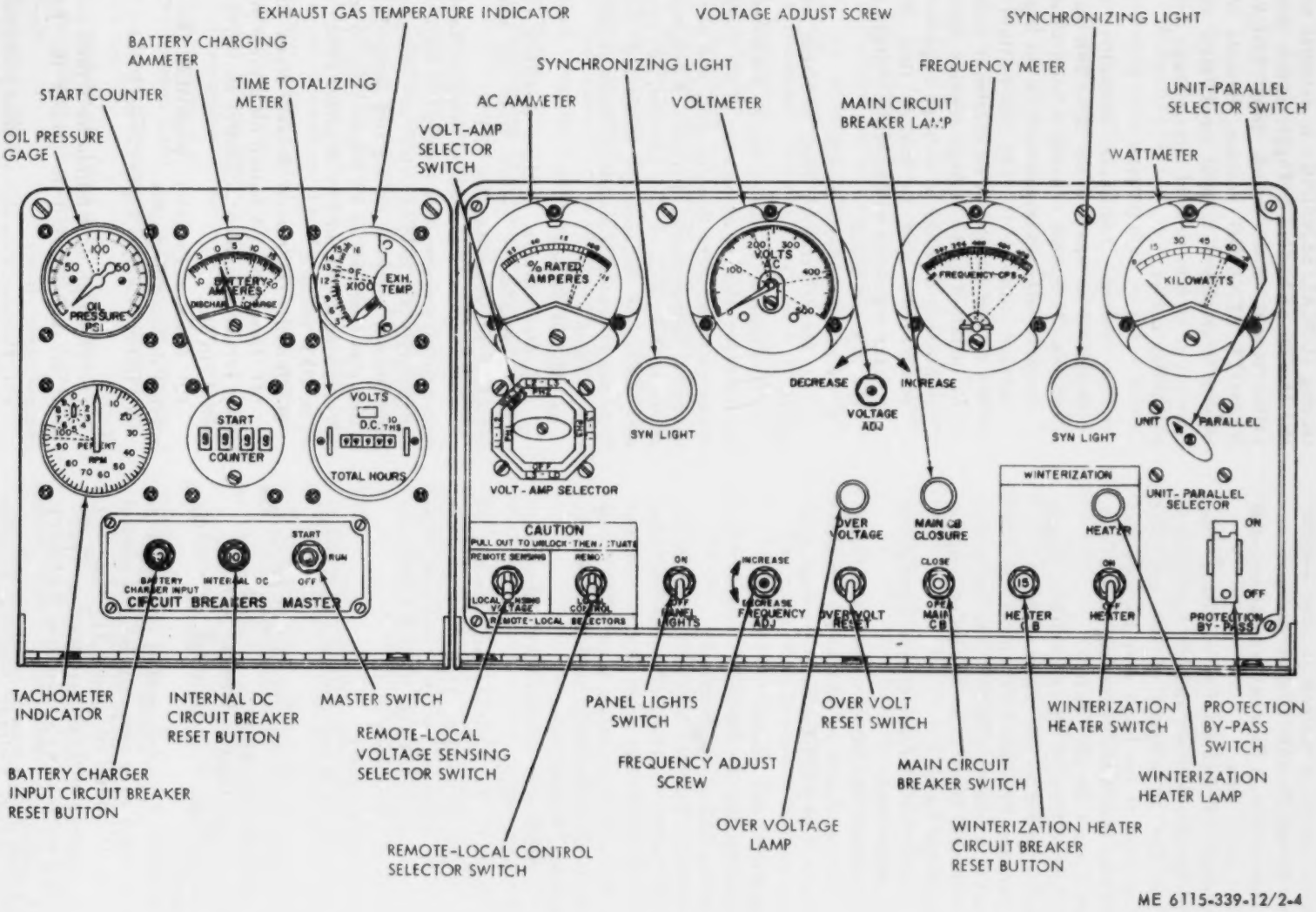


Figure 2-1. Controls and instruments.

Section IV. OPERATION UNDER USUAL CONDITIONS

2-8. General

a. The instructions in this section are published for the information and guidance of the personnel responsible for operating this equipment.

b. The operator must know how to perform every operation of which the generator set is capable. This section gives instructions on starting and stopping, basic motions, and on coordinating the basic motions to perform the specific task for which the equipment is designed. Since nearly every job presents a different problem, the operator may have to vary given procedures to fit the individual job.

WARNING

Turbine or compressor failures caused by foreign material entering the generator set may cause injury to personnel in the immediate area. During engine start, do not stand or work in the stand clear areas shown in figure 2-5.

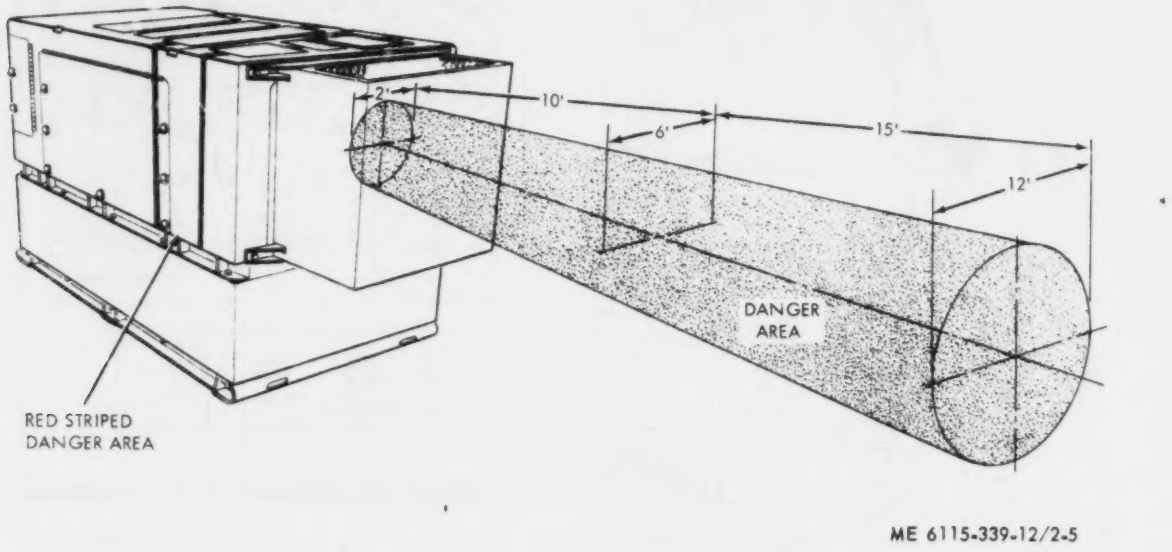


Figure 2-5. Engine operating stand clear area.

2-9. Starting

a. Preparation For Starting.

(1) Remove enclosure cover assembly (fig. 1-1).

(2) Release and raise instrument panel protective screen assembly (fig. 1-1).

(3) Perform daily preventive maintenance checks and services (para 3-4).

(4) Check load requirements.

(5) When generator set is to be operated for the first time since receipt, or has not been operated for an extended period, perform following procedures.

(a) Open auxiliary fuel tank bleed air valve (fig. 4-3).

(b) Depress pump prime switch and hold until fuel is emitted from auxiliary fuel tank bleed air valve.

(c) Release pump prime switch button and close auxiliary fuel tank bleed valve.

(d) Prime the engine fuel system (fig. 2-6).

WARNING

When preserving, depreserving, or priming engine fuel system, make certain igniter plug electrical lead assembly is completely insulated to prevent accidental shock to personnel or ignition of fumes from atomizer fuel line.

(5) If a new generator set is being operated for the first time, depreservation procedure must be completed as described in paragraph 2-1.

(6) Check for proper positioning of the following devices:

(a) UNIT-PARALLEL SELECTOR switch (fig. 2-4) in UNIT position for single unit operation or PARALLEL position for parallel operation.

(b) REMOTE-LOCAL CONTROL SELECTOR switch in local position.

(c) REMOTE-LOCAL VOLTAGE

SENSING SELECTOR in LOCAL SENSING position or REMOTE SENSING whichever is appropriate. Refer to paragraph 2-3 *d* for connection of remote sensing circuit.

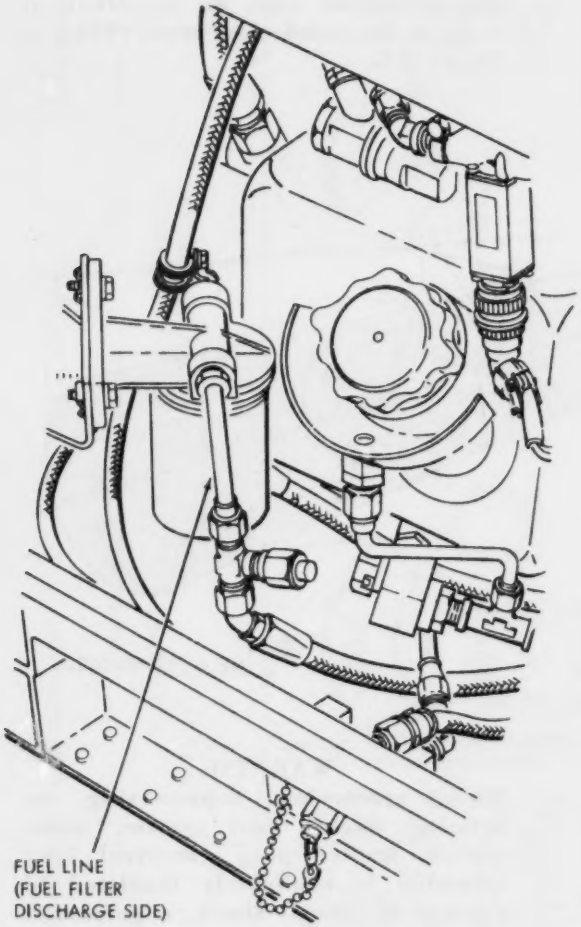
(d) Internally wired plug for REMOTE CONTROL J14 receptacle (fig. 2-3) securely installed.

CAUTION

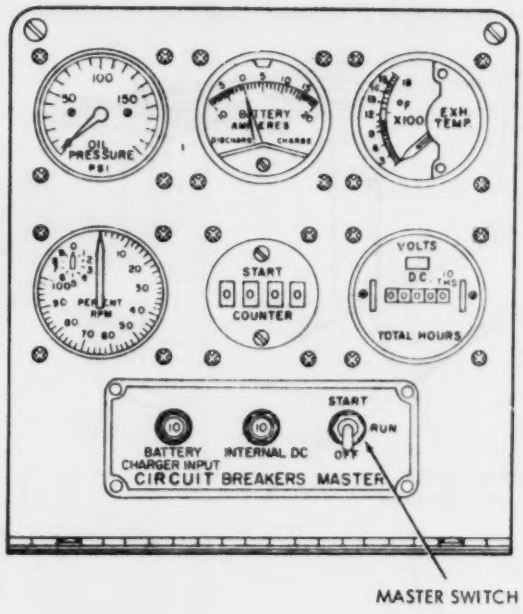
If remote control receptacle J14 is not capped with its internally wired plug, it will not be possible to adjust the generator frequency with the frequency adjust screw.

(e) PROTECTION BYPASS switch in OFF position with red lockout guard in closed position.

b. Starting. Refer to figure 2-7 and start the generator set.



A. FUEL FILTER ASSEMBLY



B. ENGINE CONTROLS INSTRUMENT PANEL ASSEMBLY

STEP 1. GRAVITY FEED FUEL FROM FUEL SUPPLY TO FUEL IN FITTING ON LEFT SIDE OF GENERATOR SET.

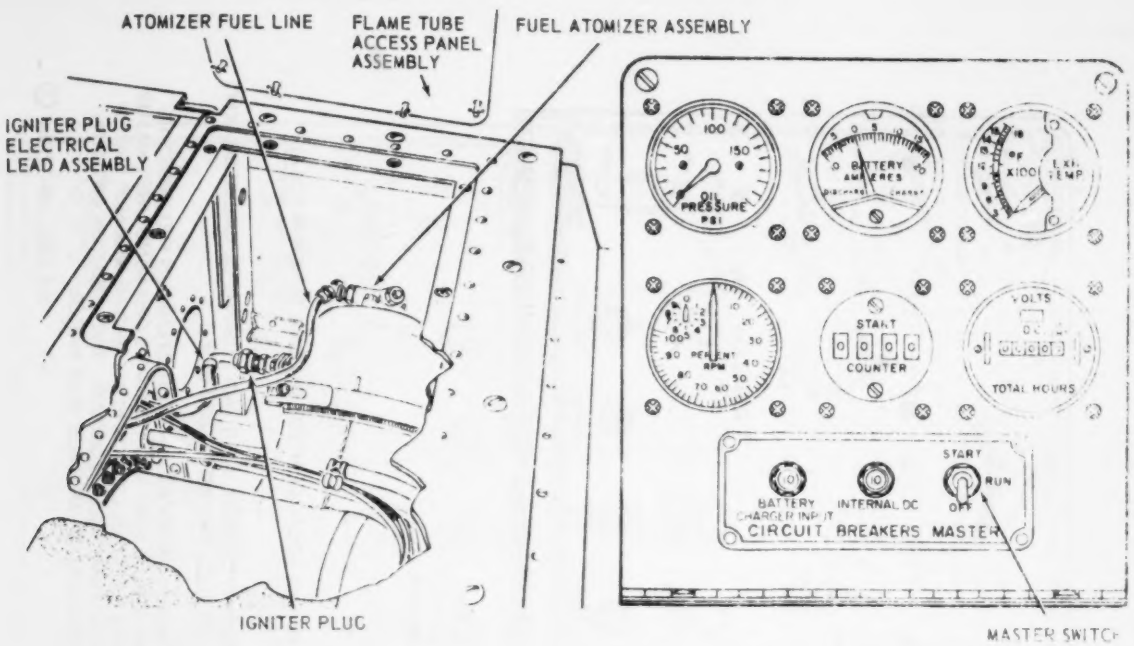
STEP 2. LOOSEN FUEL LINE CONNECTION ON DISCHARGE SIDE OF FUEL FILTER ASSEMBLY TO PERMIT DISCHARGE OF FUEL WHEN MAIN FUEL PUMP IS RUNNING.

STEP 3. PLACE MASTER SWITCH IN RUN POSITION AND ALLOW MAIN FUEL PUMP TO RUN UNTIL FUEL APPEARS ON DISCHARGE SIDE OF FUEL FILTER ASSEMBLY.

STEP 4. PLACE MASTER SWITCH IN OFF POSITION AND TIGHTEN FUEL LINE.

ME 6115-339-12/2-6 (1)

Figure 2-6. Priming the fuel system (sheet 1 of 2).



C. FUEL ATOMIZER ASSEMBLY AND IGNITER PLUG

D. ENGINE CONTROLS INSTRUMENT PANEL ASSEMBLY

STEP 5. DISCONNECT IGNITER PLUG ELECTRICAL LEAD ASSEMBLY FROM IGNITER PLUG. GROUND LEAD ASSEMBLY BY TOUCHING CONTROL SPRING IN LEAD TO IGNITER PLUG THEN CAREFULLY INSULATE LEAD ASSEMBLY WITH ELECTRICAL TAPE.

WARNING: THE IGNITER PLUG ELECTRICAL LEAD ASSEMBLY MUST BE GROUNDED AS SOON AS IT IS REMOVED FROM IGNITER PLUG. HIGH VOLTAGE IS LIKELY TO BE PRESENT. THE STARTER WILL BE OPERATED TO PRIME ENGINE AND IGNITER PLUG ELECTRICAL LEAD ASSEMBLY WILL HAVE HIGH VOLTAGE PRESENT. MAKE CERTAIN LEAD ASSEMBLY IS COMPLETELY INSULATED TO PREVENT ACCIDENTAL SHOCK TO PERSONNEL OR IGNITION OF FUEL FUMES FROM ATOMIZER FUEL LINE.

STEP 6. DISCONNECT ATOMIZER FUEL LINE FROM FUEL ATOMIZER ASSEMBLY. EXTEND LINE INTO SUITABLE CONTAINER.

STEP 7. PLACE MASTER SWITCH IN RUN POSITION FOR 30 SECS TO ALLOW EXTERNAL FUEL PUMP AND MAIN FUEL PUMP TO BEGIN FUEL FLOW. THEN PLACE MASTER SWITCH IN START POSITION UNTIL FUEL FLOWS INTO CONTAINER.

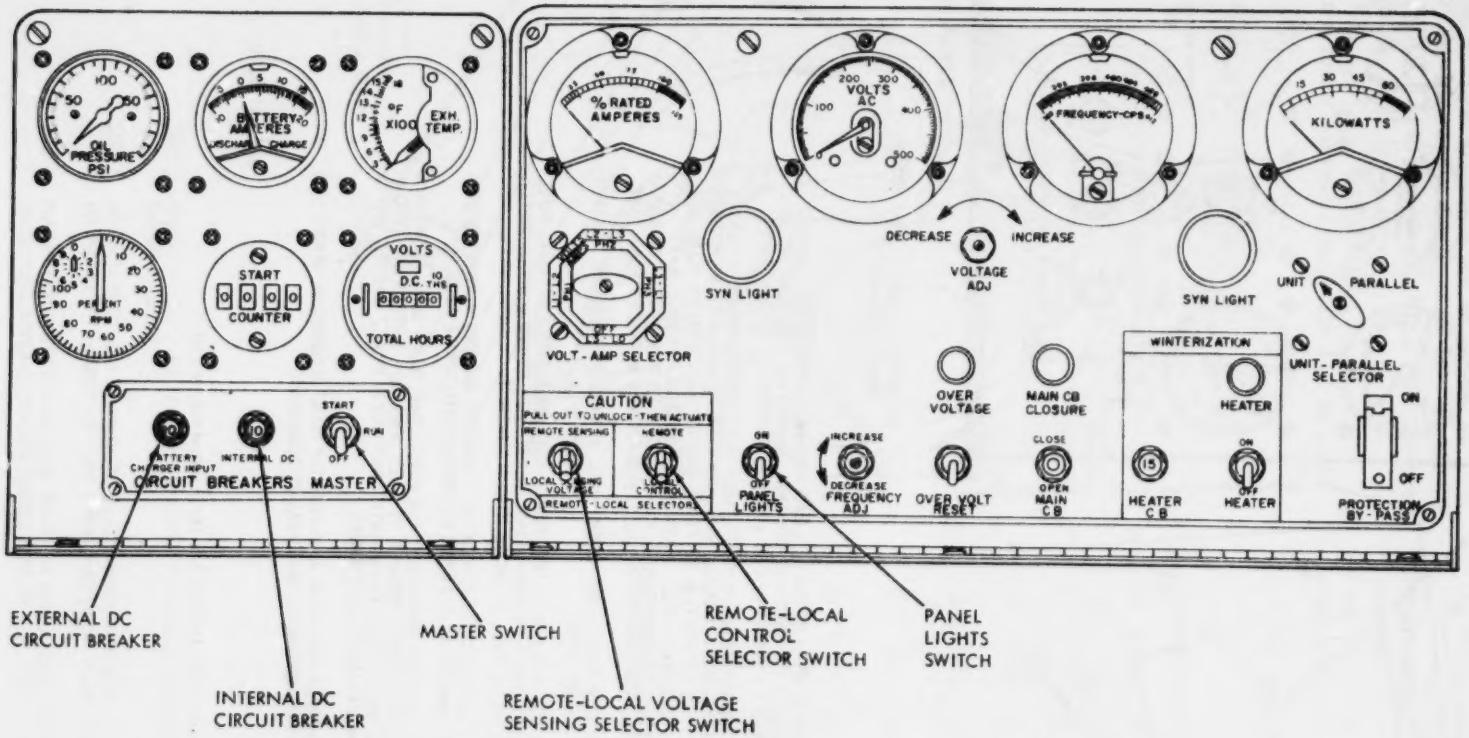
CAUTION: DO NOT EXCEED STARTER DUTY CYCLE OF 1 MINUTE ON AND 4 MINUTES OFF. OVERHEATING AND DAMAGE TO STARTER MOTOR MAY OTHERWISE RESULT.

NOTE: IF GENERATOR SET IS TO BE OPERATED FOR FIRST TIME, MAKE SURE FLOW FROM ATOMIZER FUEL LINE DURING PRIMING IS FUEL AND NOT PRESERVATIVE OIL. CONTINUE PRIMING UNTIL FUEL FLOWS INTO CONTAINER. PLACE MASTER SWITCH IN OFF POSITION WHEN FUEL FLOW OCCURS.

STEP 8. INSTALL THE ATOMIZER FUEL LINE AND IGNITER PLUG ELECTRICAL LEAD ASSEMBLY IN REVERSE ORDER OF REMOVAL PROCEDURES.

ME 6115-339-12: 2-6 (2)

Figure 2-6. Priming the fuel system (sheet 2 of 2).



CAUTION: REMOTE CONTROL RECEPTACLE J-14 MUST BE SECURELY CAPPED WITH ITS INTERNALLY WIRED PLUG. IF RECEPTACLE J-14 IS NOT CAPPED WITH INTERNALLY WIRED PLUG, IT WILL NOT BE POSSIBLE TO ADJUST THE GENERATOR FREQUENCY WITH THE APPROPRIATE SCREW ON THE CONTROL PANEL.

NOTE: IF LIGHT CONDITION REQUIRES ILLUMINATION OF CONTROL PANELS, PLACE PANEL LIGHTS SWITCH IN ON POSITION.

STEP 1. PLACE REMOTE-LOCAL VOLTAGE SENSING SELECTOR SWITCH IN LOCAL SENSING POSITION IF REMOTE VOLTAGE SENSING IS NOT EMPLOYED.

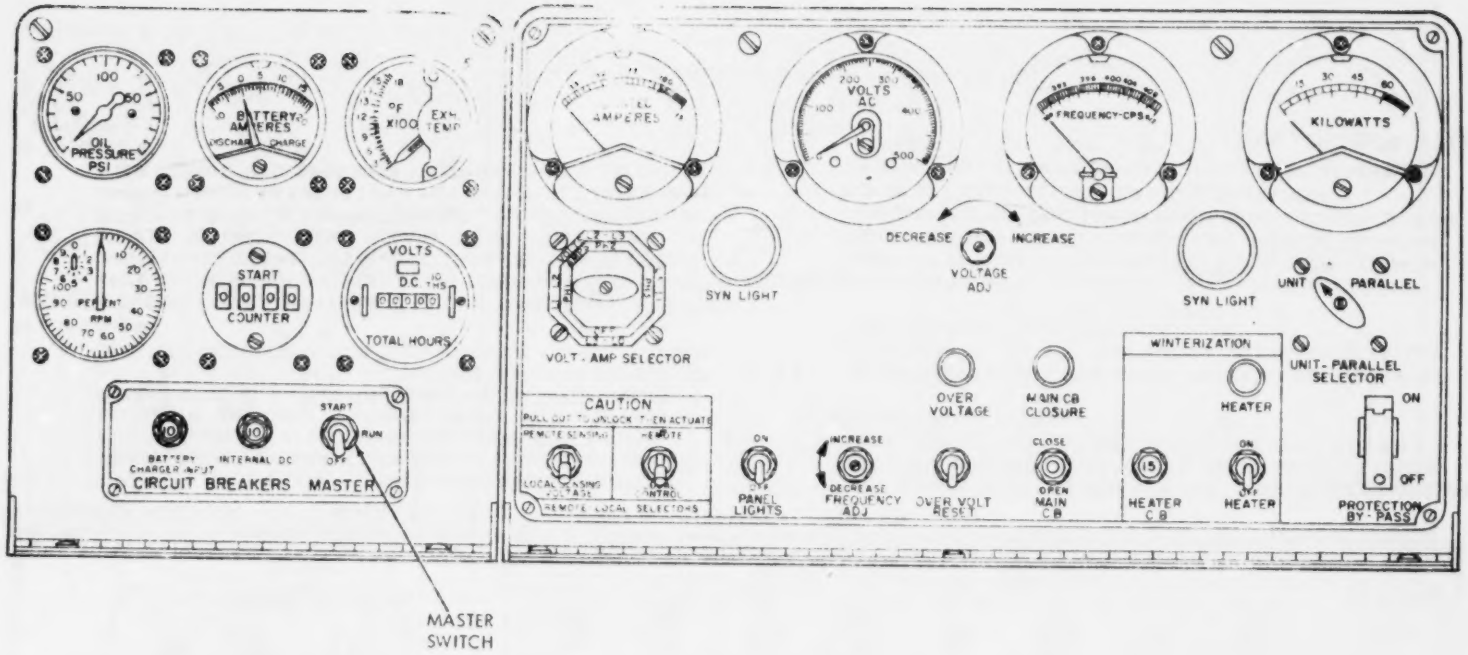
STEP 2. PLACE REMOTE LOCAL CONTROL SELECTOR SWITCH IN LOCAL POSITION.

STEP 3. PRESS BATTERY CHARGER INPUT AND INTERNAL DC CIRCUIT BREAKERS TO INSURE THAT THEY ARE CLOSED (RESET).

STEP 4. PLACE MASTER SWITCH IN RUN POSITION. MAIN FUEL PUMP WILL AUTOMATICALLY START AND CONTINUE OPERATING UNTIL MASTER SWITCH IS PLACED IN OFF POSITION. ENGINE WILL NOT START IF MAIN FUEL PUMP FAILS TO OPERATE. FEEL VIBRATION OR LISTEN FOR OPERATION OF MAIN FUEL PUMP MOTOR.

ME 6115-339-12/2-7 (1)

Figure 2-7. Starting the generator set (sheet 1 of 5).



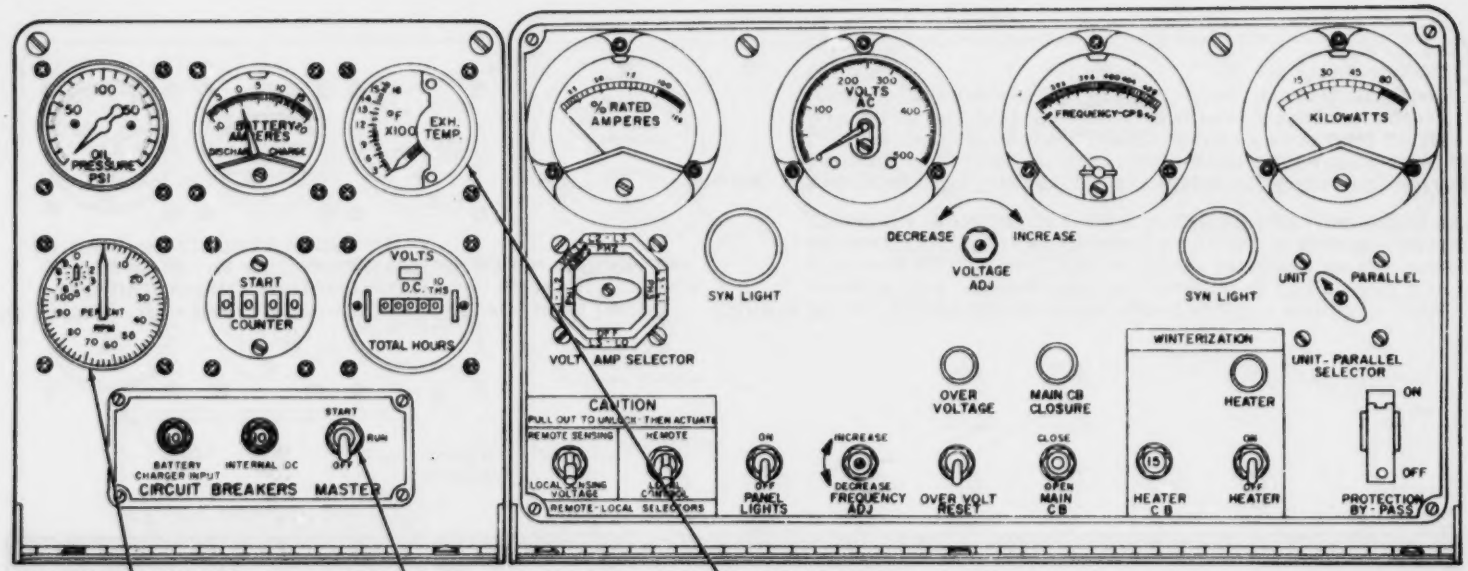
STEP 5. MOMENTARILY PLACE MASTER SWITCH IN START POSITION. ENGINE WILL AUTOMATICALLY START AND ACCELERATE. WHEN MASTER SWITCH IS RELEASED, IT WILL AUTOMATICALLY RETURN TO RUN POSITION AND ENGINE WILL CONTINUE TO OPERATE.

CAUTION: DO NOT EXCEED STARTER MOTOR DUTY CYCLE OF 1 MINUTE ON AND 4 MINUTES OFF. OVERHEATING AND DAMAGE TO STARTER MOTOR MAY OTHERWISE RESULT. MAKE SURE AIR INTAKE OPENINGS ARE FREE FROM OBSTRUCTIONS TO INSURE ADEQUATE AIR INTAKE TO ENGINE. ERRATIC OPERATION OR FAILURE OF ENGINE TO OPERATE MAY OTHERWISE RESULT.

NOTE: APPROXIMATELY 3 START CYCLES MAY BE EXPECTED FROM FULLY CHARGED BATTERIES WHEN ATTEMPTING TO START THE GENERATOR SET IN EXTREME COLD WEATHER CONDITIONS. APPROXIMATELY 8 TO 10 START CYCLES MAY BE EXPECTED DURING NORMAL OR EXTREME HOT WEATHER CONDITIONS. THIS ASSUMES NO CHARGING OF BATTERIES BETWEEN START CYCLES.

ME 6115-339-12/2-7 (2)

Figure 2-7. Starting the generator set (sheet 2 of 3).



TACHOMETER INDICATOR MASTER SWITCH EXHAUST GAS TEMPERATURE INDICATOR

STEP 6. LISTEN FOR ENGINE COMBUSTION (CHARACTERISTIC ROAR) AND OBSERVE TACHOMETER INDICATOR DURING ENGINE ACCELERATION. ENGINE COMBUSTION SHOULD OCCUR AND ENGINE SHOULD ACCELERATE SMOOTHLY TO NORMAL OPERATING RPM OF 100 ± 3 PERCENT IN 15 TO 30 SECONDS. PLACE MASTER SWITCH IMMEDIATELY IN OFF POSITION TO STOP ENGINE IF ENGINE COMBUSTION DOES NOT OCCUR OR ENGINE DOES NOT HAVE NORMAL ACCELERATION.

CAUTION: IF ENGINE COMBUSTION FAILS TO OCCUR, WAIT AT LEAST 5 MINUTES AFTER MASTER SWITCH IS PLACED IN OFF POSITION BEFORE ATTEMPTING RESTART. THIS ALLOWS ANY ACCUMULATED FUEL IN ENGINE PLENUM TO DRAIN FROM PLENUM DRAIN FITTING AND EVAPORATE BEFORE ATTEMPTING RESTART. ACCUMULATED FUEL IN ENGINE PLENUM MAY RESULT IN A HOT (FLAMING) START OR OVERSPEED CONDITION DURING NEXT STARTING ATTEMPT AND ENGINE MAY BE EXTENSIVELY DAMAGED THEREBY. ENGINE OVERTEMPERATURE AND OVERSPEED PROTECTION DEVICES ARE OF NO VALUE UNDER THESE CONDITIONS. FOR THIS REASON, ALWAYS BE SURE THAT PLENUM DRAIN IS OPEN.

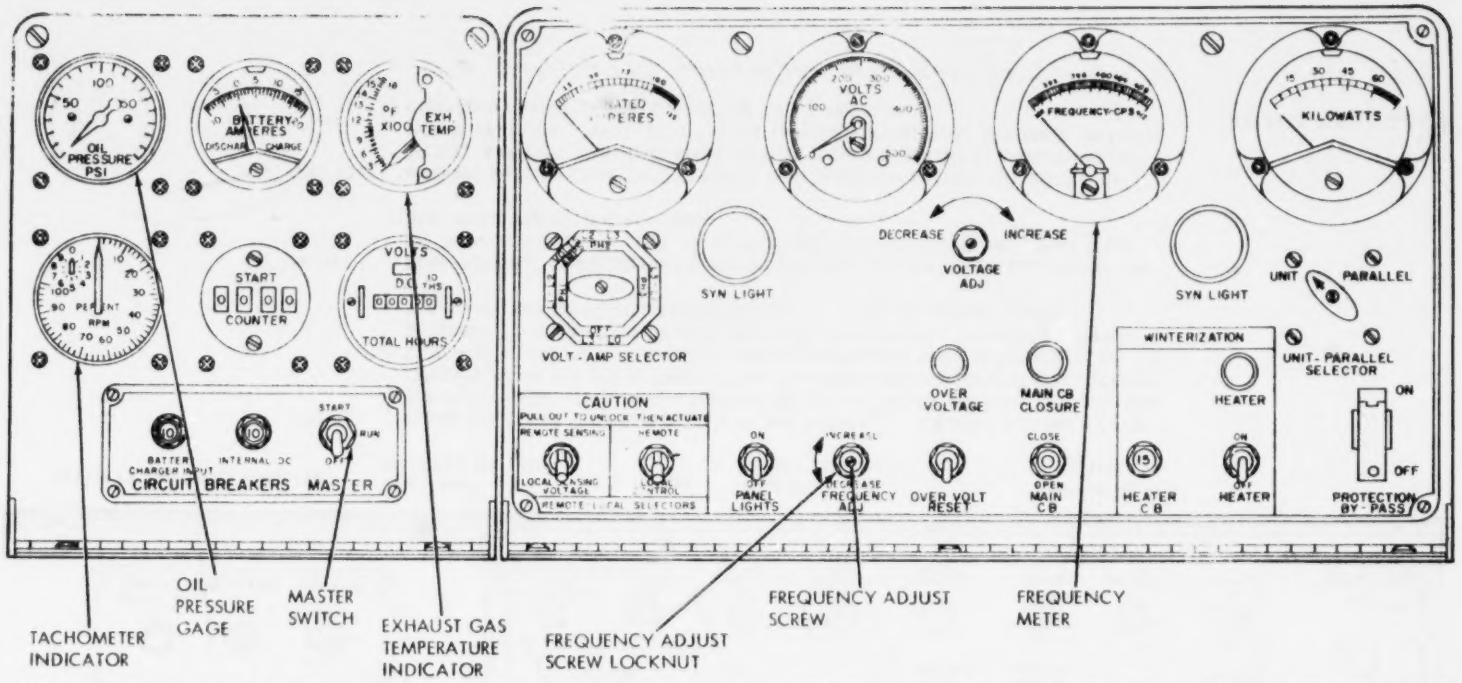
STEP 7. OBSERVE EXHAUST GAS TEMPERATURE INDICATOR DURING ENGINE ACCELERATION. EXHAUST GAS TEMPERATURE SHALL NOT EXCEED 1350°F FOR MORE THAN 5 SECONDS.

CAUTION: PLACE MASTER SWITCH IMMEDIATELY IN OFF POSITION TO STOP ENGINE IF EXHAUST GAS TEMPERATURE EXCEEDS 1350°F FOR MORE THAN 5 SECONDS DURING ACCELERATION. DAMAGE TO ENGINE COMPONENTS MAY RESULT FROM TEMPERATURES EXCEEDING 1350°F FOR MORE THAN 5 SECONDS DURING ACCELERATION.

STEP 8. OBSERVE THAT NO SMOKE OR FLAME IS EMITTED FROM MUFFLER ASSEMBLY.

ME 6115-339-12/2-7 (3)

Figure 2-7. Starting the generator set (sheet 3 of 5).



STEP 9. OBSERVE THAT OIL PRESSURE GAGE INDICATES 90 ± 10 PSIG.

CAUTION: PLACE MASTER SWITCH IMMEDIATELY IN OFF POSITION TO STOP ENGINE IF OIL PRESSURE GAGE INDICATES LESS THAN 80 PSIG OR MORE THAN 100 PSIG. ABNORMAL OIL PRESSURE MAY CAUSE DAMAGE TO ENGINE.

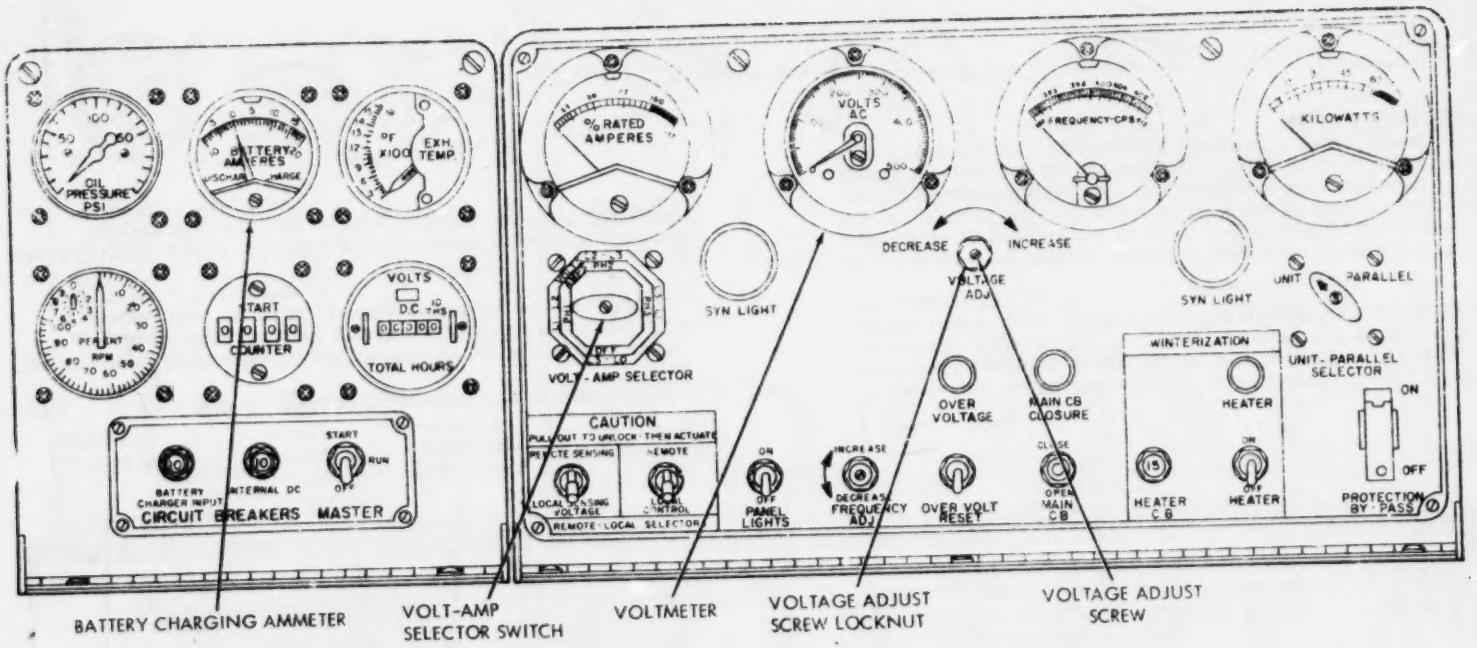
STEP 10. OBSERVE THAT EXHAUST GAS TEMPERATURE INDICATOR DOES NOT INDICATE MORE THAN 1310°F FOR STEADY STATE OPERATIONS OF THE SET AT FULL LOAD.

CAUTION: IF EXHAUST GAS TEMPERATURE EXCEEDS 1310°F DURING STEADY STATE OPERATION OF ENGINE, PLACE MASTER SWITCH IMMEDIATELY IN OFF POSITION TO STOP ENGINE. EXCESSIVE EXHAUST GAS TEMPERATURE DURING STEADY STATE OPERATION OF THE ENGINE MAY CAUSE EXTENSIVE DAMAGE TO ENGINE.

STEP 11. ALLOW ENGINE TO OPERATE 2 MINUTES AND THEN OBSERVE THAT FREQUENCY METER INDICATES 400 ± 1 CPS. LOOSEN FREQUENCY ADJUST SCREW LOCKNUT AND ADJUST FREQUENCY ADJUST SCREW CLOCKWISE (INCREASE) OR COUNTERCLOCKWISE (DECREASE) WITH SCREWDRIVER AS REQUIRED TO OBTAIN DESIRED INDICATION. TIGHTEN LOCKNUT WITHOUT CHANGING ADJUSTED POSITION OF FREQUENCY ADJUST SCREW.

ME 6115-339-12/2-7 (4)

Figure 2-4. Starting the generator set (sheet 4 of 5).



STEP 12. PLACE VOLT-AMP SELECTOR SWITCH IN A-B POSITION. OBSERVE VOLTMETER FOR 208 VOLTS INDICATION WHEN GENERATOR SET IS CONNECTED FOR LOW VOLTAGE OPERATION OR 416 VOLTS INDICATION FOR HIGH VOLTAGE OPERATION. LOOSEN VOLTAGE ADJUST SCREW LOCKNUT AND ADJUST SCREW WITH SCREWDRIVER AS REQUIRED TO OBTAIN THE DESIRED VOLTAGE INDICATION. TIGHTEN LOCKNUT WITHOUT CHANGING ADJUSTED POSITION OF VOLTAGE ADJUST SCREW.

NOTE: LOW VOLTAGE ADJUSTMENT RANGE OF VOLTAGE ADJUST SCREW IS AT LEAST 198 TO 219 VOLTS LINE-TO-LINE. HIGH VOLTAGE ADJUSTMENT RANGE IS AT LEAST 396 TO 436 VOLTS LINE-TO-LINE.

STEP 13. OBSERVE BATTERY CHARGING CURRENT INDICATED ON BATTERY CHARGING AMMETER. BATTERY CHARGING AMMETER WILL INDICATE ABOUT 11 AMPS IF BATTERY VOLTAGE IS LOW. WHEN BATTERY HAS CHARGED TO NORMAL VOLTAGE, BATTERY CHARGING AMMETER SHALL INDICATE 2 TO 5 AMPS.

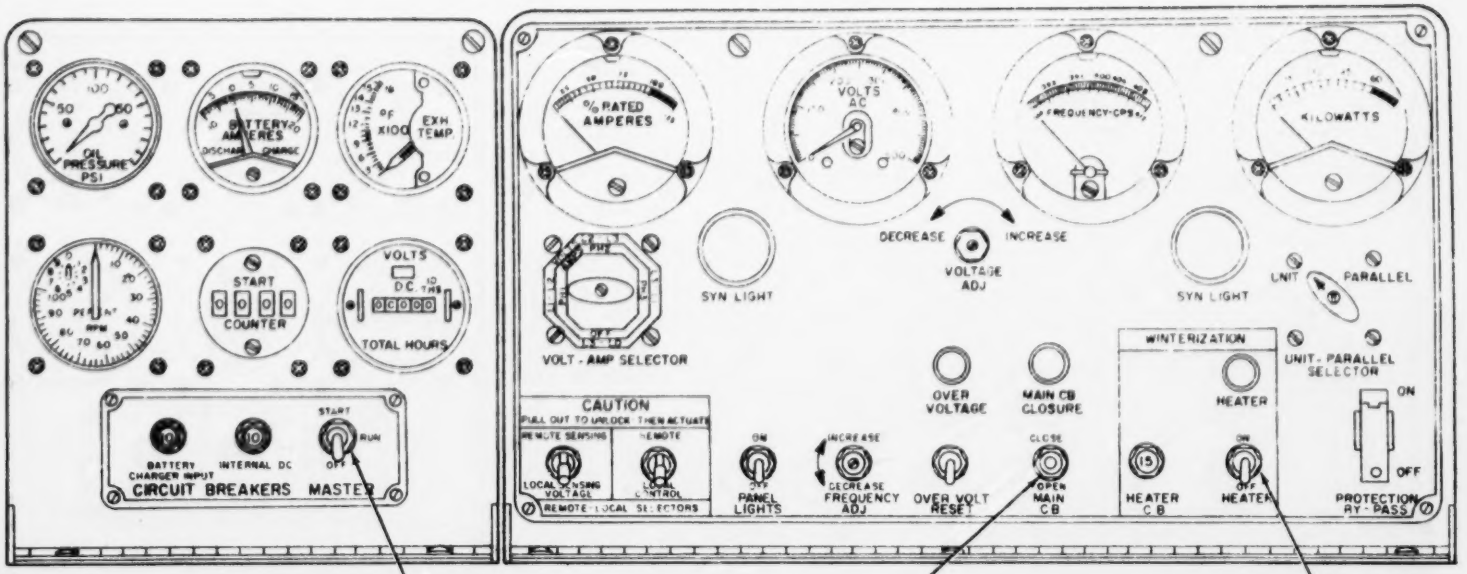
ME 6115-339-12/2-7 (5)

Figure 2-7. Starting the generator set (sheet 5 of 5).

2-10. Stopping

a. Refer to figure 2-8 and stop the generator set.

b. Perform the necessary daily preventive maintenance checks and services.



MASTER SWITCH

MAIN CIRCUIT BREAKER SWITCH

WINTERIZATION HEATER SWITCH

STEP 1. PLACE MAIN CIRCUIT BREAKER SWITCH IN OPEN POSITION TO REMOVE ELECTRICAL LOAD BEFORE ENGINE SHUTDOWN.

NOTE: OPERATE ENGINE FOR APPROXIMATELY 2 MINUTES UNDER NO-LOAD CONDITIONS PRIOR TO STOPPING ENGINE. THIS PERMITS GRADUAL COOLING OF ENGINE.

STEP 2. PLACE MASTER SWITCH IN OFF POSITION AND ALLOW ENGINE TO COME TO COMPLETE STOP.

STEP 3. INSURE THAT WINTERIZATION HEATER SWITCH IS IN THE OFF POSITION TO AVOID DISCHARGE OF THE BATTERIES THROUGH THE BATTERY ELECTROLYTE TEMPERATURE SENSOR.

ME 6115-339-12/2-8

Figure 2-8. Stopping the generator set.

2-11. Operation of Equipment

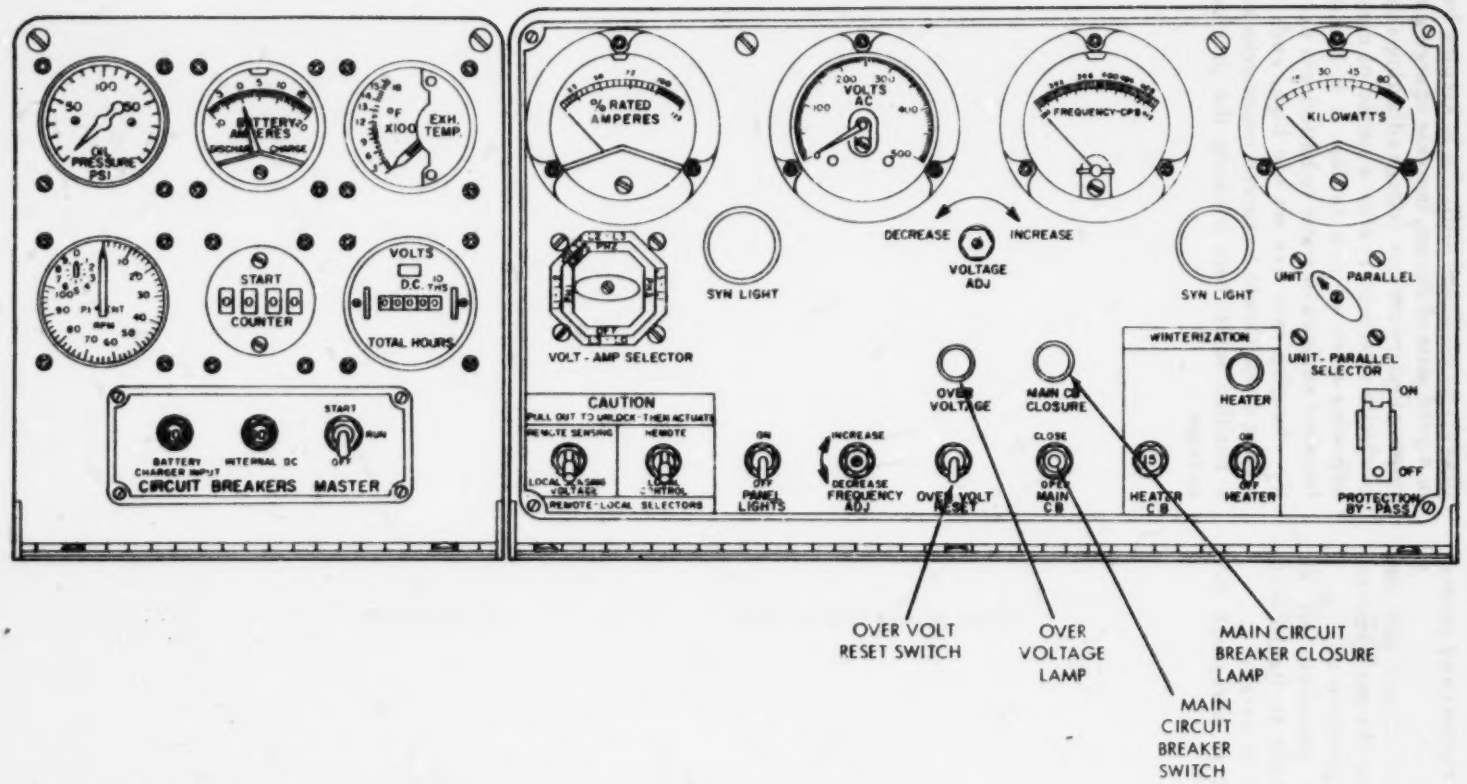
a. General. When the generator set is in operation, make careful observations of instruments to be sure the unit is operating normally. Refer to paragraph 2-7 for descriptions and normal indications of the instruments.

b. Operation. Refer to figure 2-7 and start the generator set; figure 2-8 to stop the generator set and to figure 2-9 to operate the generator set.

c. Parallel Operation. Start generator set as described in paragraph 2-9. Refer to figure 2-10 and operate the generator sets in parallel.

d. Remote Operation. Refer to paragraph 2-3 for description of remote operation of the equipment.

e. Battery Charger Operation. If operating experience with the generator set over a period of time shows continued difficulty in keeping batteries in a good state of charge, increase charging rate by turning battery charger voltage adjusting screw in a clockwise direction. If after a period of usage with adjusting screw at new setting, it is found that frequent addition of water to batteries is necessary, the charging rate was set too high, and the adjusting screw should be turned counterclockwise to a position somewhere between the previous two settings.



WARNING: IN CASE OF ACCIDENT FROM ELECTRIC SHOCK, SHUTDOWN GENERATOR SET AT ONCE. IF GENERATOR SET CANNOT BE SHUTDOWN, FREE VICTIM FROM LIVE CONDUCTOR WITH A BOARD OR ANY NONCONDUCTOR. IF VICTIM IS UNCONSCIOUS, APPLY ARTIFICAL RESPIRATION AND OBTAIN MEDICAL HELP.

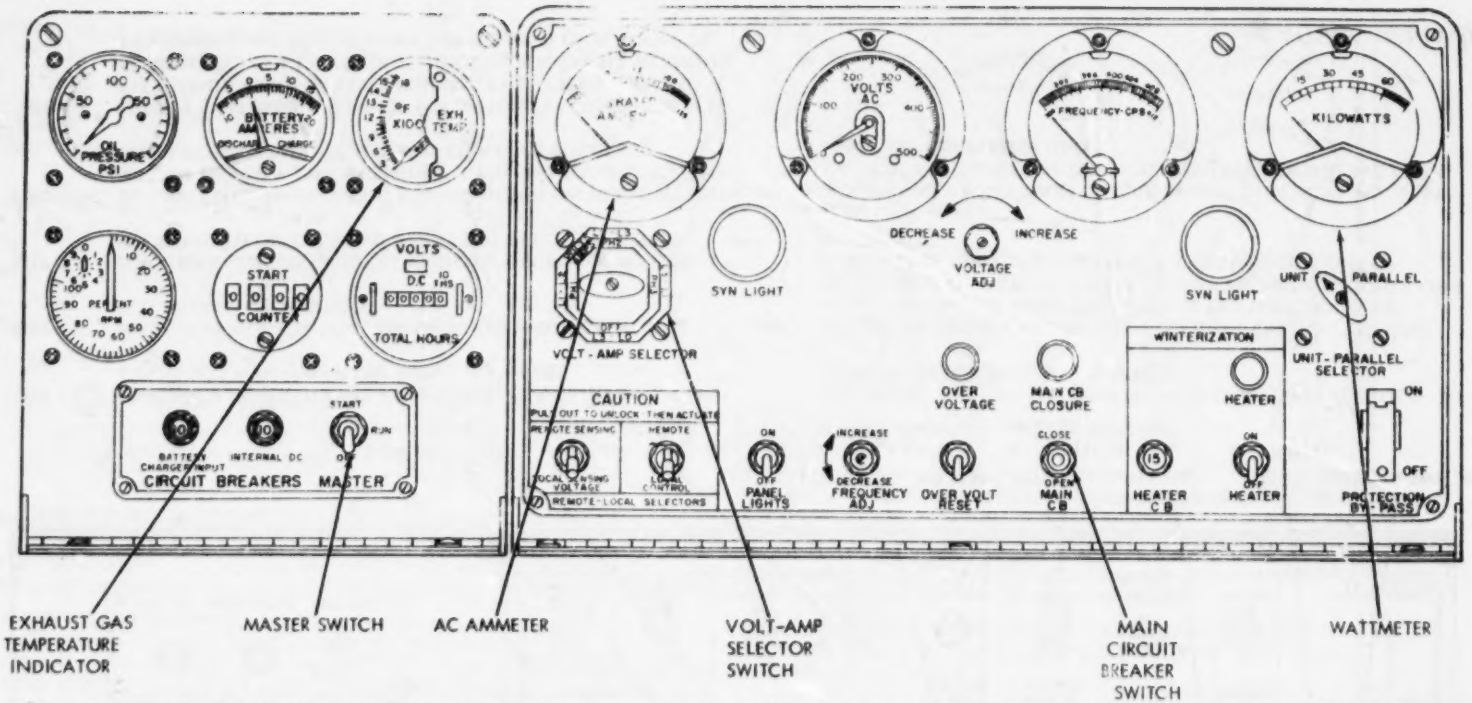
STEP 1. MOMENTARILY PLACE MAIN CIRCUIT BREAKER SWITCH IN CLOSE POSITION.

STEP 2. OBSERVE THAT MAIN CIRCUIT BREAKER CLOSURE LAMP ILLUMINATES TO INDICATE CONNECTION OF ELECTRICAL LOAD.

NOTE: IF OVER VOLTAGE LAMP ILLUMINATES WHEN ELECTRICAL LOAD IS CONNECTED OR DURING OPERATION OF GENERATOR SET, AN OVERVOLTAGE CONDITION HAS TRIPPED OVERVOLTAGE RELAY TO CAUSE LOSS OF EXCITATION AND DISCONNECTION OF LOAD. PLACE OVER VOLT RESET SWITCH MOMENTARILY IN UP POSITION TO RESET OVERVOLTAGE CIRCUIT WHEN CAUSE OF OVERVOLTAGE CONDITION HAS BEEN CORRECTED, THEN REPEAT STEPS 1 AND 2 ABOVE.

ME 6115-339-12/2-9 ①

Figure 2-9. Operating the generator set (sheet 1 of 2).



STEP 3. OBSERVE THAT WATTMETER INDICATES NOT MORE THAN 60 KW. IF WATTMETER INDICATES MORE THAN 60 KW, PLACE MAIN CIRCUIT BREAKER SWITCH IMMEDIATELY IN OPEN POSITION AND CHECK ELECTRICAL LOADS.

STEP 4. OBSERVE THAT EXHAUST GAS TEMPERATURE INDICATOR DOES NOT INDICATE MORE THAN 1310°F FOR STEADY STATE OPERATION OF THE SET AT FULL LOAD.

CAUTION:

IF EXHAUST GAS TEMPERATURE EXCEEDS 1310°F DURING STEADY STATE OPERATION OF ENGINE, PLACE MASTER SWITCH IMMEDIATELY IN OFF POSITION TO STOP ENGINE. EXCESSIVE EXHAUST GAS TEMPERATURE DURING STEADY STATE OPERATION OF THE ENGINE MAY CAUSE EXTENSIVE DAMAGE TO ENGINE.

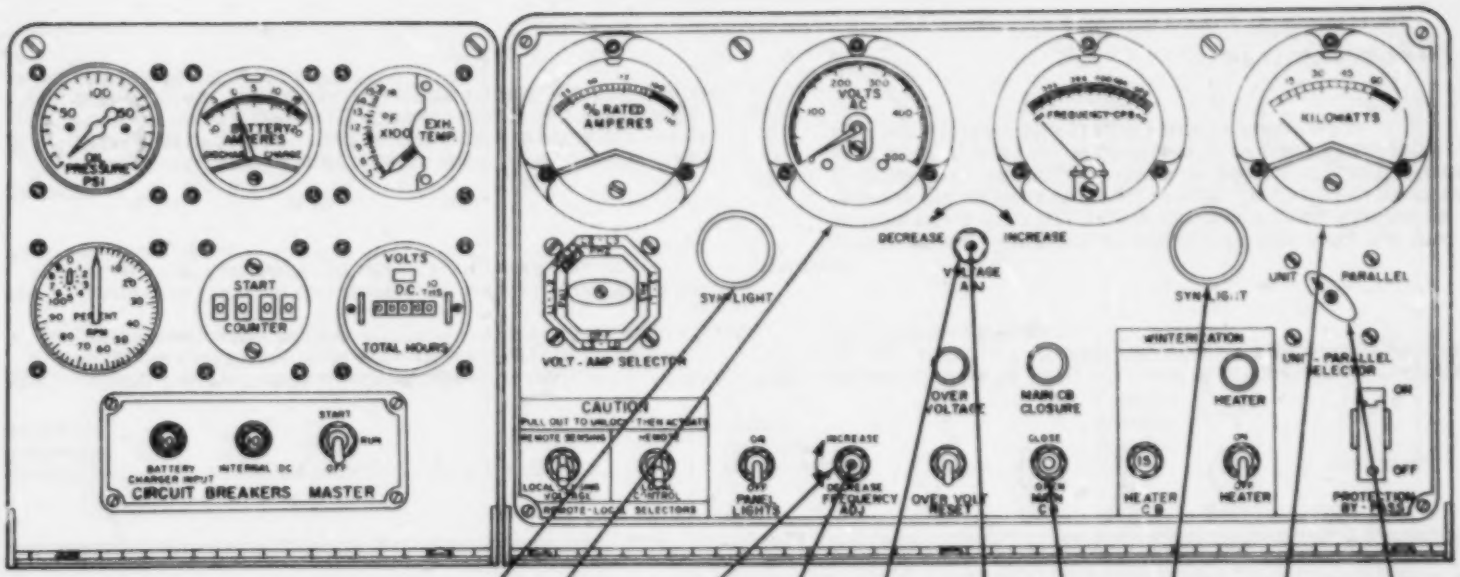
STEP 5. OBSERVE AC AMMETER WHEN VOLT-AMP SELECTOR SWITCH IS PLACED IN A-B, B-C, AND C-A POSITIONS. AC AMMETER INDICATIONS SHALL BE EQUAL WITHIN 25 PERCENT.

CAUTION:

AVOID LETTING GENERATOR SET RUN OUT OF FUEL SINCE THIS WILL INTRODUCE AIR INTO FUEL SYSTEM AND MAY REQUIRE PURGING OR PRIMING ON THE NEXT STARTING ATTEMPT. ALSO IF REPEATED OFTEN ENOUGH, THIS PRACTICE WILL RESULT IN DAMAGE TO FUEL CONTROL UNIT SINCE IT DOES NOT RECEIVE BENEFIT OF LUBRICATION FROM FUEL WHEN ENGINE STOPS DUE TO LACK OF FUEL.

ME 6115-339-12/2-9 (2)

Figure 2-9. Operating the generator set (sheet 2 of 2).



VOLTMETER

FREQUENCY ADJUST SCREW

VOLTAGE ADJUST SCREW

SYNCHRONIZING LIGHT LAMP

UNIT-PARALLEL SELECTOR SWITCH

SYNCHRONIZING LIGHT LAMP

FREQUENCY ADJUST SCREW LOCKNUT

VOLTAGE ADJUST SCREW LOCKNUT

MAIN CIRCUIT BREAKER SWITCH

WATTMETER

STEP 1. START EACH GENERATOR SET AS DESCRIBED IN PARAGRAPH 2-9 AND ALLOW SETS TO WARM UP FOR ABOUT 15 MINUTES.

STEP 2. PLACE UNIT-PARALLEL SELECTOR SWITCH ON BOTH GENERATOR SETS IN PARALLEL POSITION.

STEP 3. PLACE MAIN CIRCUIT BREAKER SWITCH ON GENERATOR SET CONNECTED TO ELECTRICAL LOAD (NO. 1 SET) IN CLOSE POSITION.

CAUTION: DO NOT CLOSE MAIN CIRCUIT BREAKER SWITCH ON NO. 2 SET UNTIL SETS ARE PROPERLY SYNCHRONIZED. EXTENSIVE DAMAGE TO ELECTRICAL COMPONENTS OF SETS MAY OTHERWISE RESULT.

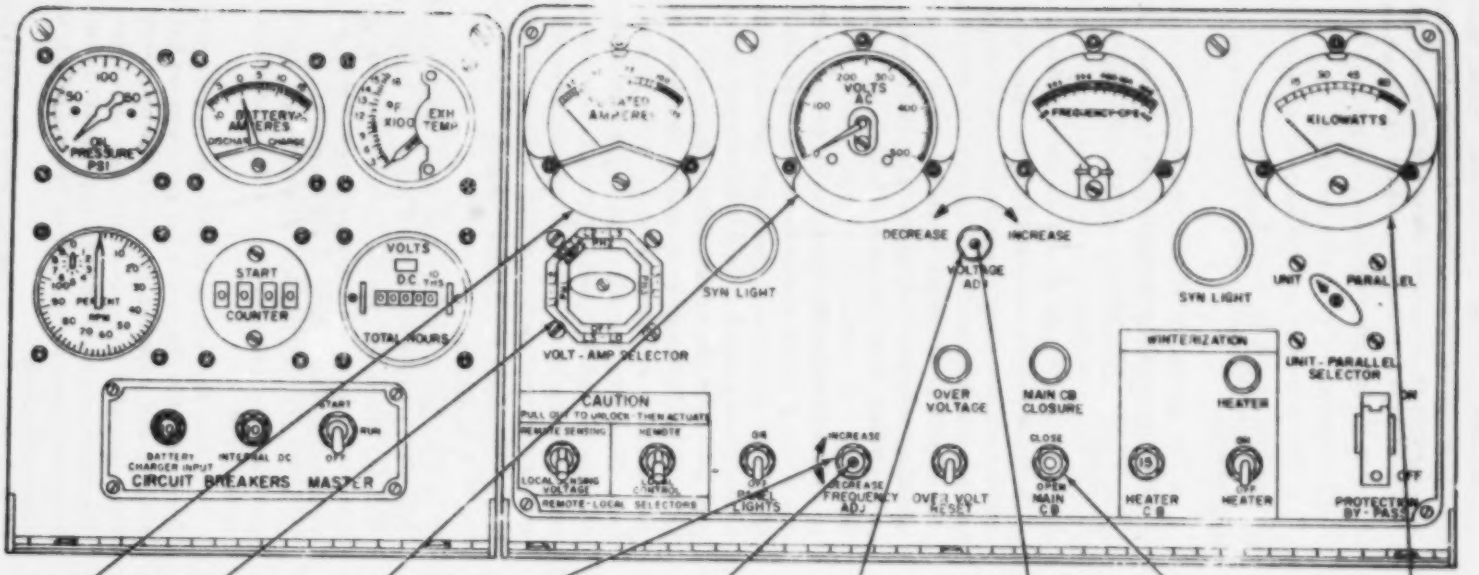
STEP 4. OBSERVE THAT INDICATIONS OF VOLTMETERS ON GENERATOR SETS ARE EQUAL AND ARE AT LEVEL REQUIRED BY ELECTRICAL LOADS. LOOSEN LOCKNUT OF VOLTAGE ADJUST SCREW ON SET REQUIRING ADJUSTMENT AND ADJUST SCREW FOR REQUIRED INDICATION ON VOLTMETER. TIGHTEN LOCKNUT WITHOUT CHANGING ADJUSTED POSITION OF VOLTAGE ADJUST SCREW.

STEP 5. LOOSEN FREQUENCY ADJUST SCREW LOCKNUT ON NO. 2 SET AND ADJUST SCREW CLOCKWISE (INCREASE) OR COUNTERCLOCKWISE (DECREASE) UNTIL RATE OF FLICKER OF SYNCHRONIZING LIGHT LAMPS IS NOT MORE THAN ONE FLICKER FOR APPROXIMATELY EVERY 5 SECONDS.

STEP 6. MOMENTARILY PLACE MAIN CIRCUIT BREAKER SWITCH ON NO. 2 SET IN CLOSE POSITION DURING PERIOD WHEN SYNCHRONIZING LIGHT LAMPS ARE COMPLETELY DARK.

ME 6115-339-12/2-10 ①

Figure 2-10. Operating two generator sets in parallel (sheet 1 of 2).



STEP 7. IF ELECTRICAL LOAD IS NOT SHARED APPROXIMATELY EQUAL BETWEEN GENERATOR SETS (INDICATED ON WATTMETERS), LOOSEN FREQUENCY ADJUST SCREW LOCKNUTS OF SETS. TURN SCREW OF MORE HEAVILY LOADED SET SLIGHTLY COUNTERCLOCKWISE, AND SCREW ON OTHER SET SLIGHTLY CLOCKWISE UNTIL LOAD IS BALANCED BETWEEN SETS. IF FREQUENCY IS NOT CORRECT FOR LOAD WHEN LOAD IS BALANCED, TURN BOTH SCREWS IN SAME DIRECTION UNTIL PROPER FREQUENCY IS OBTAINED WITHOUT UPSETTING DIVISION OF LOAD BETWEEN SETS.

STEP 8. AFTER PROPERLY DIVIDING KW LOAD, OBSERVE THAT LOAD CURRENT INDICATIONS OF AC AMMETERS OF BOTH GENERATOR SETS ARE APPROXIMATELY EQUAL WHEN MONITORING SAME PHASE (VOLT-AMP SELECTOR SWITCHES ARE IN SAME POSITION). IF INDICATIONS ARE NOT APPROXIMATELY EQUAL, LOOSEN VOLTAGE ADJUST SCREW LOCKNUTS OF SETS; TURN SCREW ON MORE HEAVILY LOADED SET SLIGHTLY COUNTERCLOCKWISE, AND SCREW ON OTHER SET SLIGHTLY CLOCKWISE, UNTIL CURRENT INDICATIONS ARE EQUAL BETWEEN SETS. IF VOLTMETERS ON SETS INDICATE INCORRECT VOLTAGE FOR LOAD, TURN BOTH SCREWS IN SAME DIRECTION UNTIL CORRECT VOLTAGE IS OBTAINED WITHOUT UPSETTING DIVISION OF LOAD CURRENT BETWEEN SETS.

STEP 9. TIGHTEN LOCKNUTS OF FREQUENCY ADJUST AND VOLTAGE ADJUST SCREWS WITHOUT CHANGING ADJUSTED POSITIONS OF SCREWS.

NOTE: IF THERE IS ANY EVIDENCE OF INSTABILITY (LOAD SWAPPING BETWEEN GENERATOR SETS) AT THE TIME SETS ARE PARALLELED, MOMENTARILY PLACE MAIN CIRCUIT BREAKER SWITCH ON ONE OF SETS IN OPEN POSITION AND REPORT CONDITION TO DIRECT SUPPORT MAINTENANCE. LOAD SWAPPING WILL PROBABLY MANIFEST ITSELF BY EXTREME CONDITION OF VIBRATION AND RAPID PERIODIC FLUCTUATIONS (SURGING) IN SOUND OF ENGINE. LOAD SWAPPING WILL PROBABLY BE TO RAPID TO BE NOTICED ON WATTMETERS AND AC AMMETERS OF SETS.

CAUTION: CONTINUED OPERATION OF GENERATOR SETS DURING AN UNSTABLE CONDITION CAN CAUSE DAMAGE TO SETS.

ME 6115-339-12/2-10 (2)

Figure 2-10. Operating two generator sets in parallel (sheet 2 of 2).

Section V. OPERATION UNDER UNUSUAL CONDITIONS

2-12. Operation in Extreme Cold (Below 0° F.)

a. The generator set will operate satisfactorily at ambient temperatures as low as —65° F. However, special precautions should be observed for the fuel system and batteries. The battery heater should be operated when ambient temperatures are below —25° F. to condition the batteries for starting. Approximately 1 hour of heating will be required at —65° F; heating time for temperatures between —25° F. and —65° F. will be proportionately less.

b. Allow engine to reach normal operating temperature before applying load. Keep fuel tank full at all times.

c. Service main fuel filter (fig. 4-15).

d. Keep batteries fully charged (para 2-11).

e. Lubricate in accordance with LO 5-6115-339-12.

CAUTION

Operate the generator set for at least 1 hour after adding water to batteries. Water may freeze unless it is immediately mixed with electrolyte. Charging voltage and current required to maintain batteries fully charged varies with ambient temperatures. The battery charger may require adjustment if charging current is too low to maintain batteries at full charge.

CAUTION

An external 24 v dc power source may be connected to the 24 v dc SLAVE RECEPTACLE J15 (fig. 2-3) for operating the battery heater and starting the generator set in the event of battery failure. When attaching an external power source to J15, be sure that polarity of power supply corresponds to markings on receptacle. Failure to do so will result in damage to equipment.

f. With generator set at standstill at temperatures as low as —65° F., the batteries (when initially fully charged) have sufficient capacity to operate the battery heater for 12 hours (in a cycling mode) and will be able to start the engine at least once at the end of the 12 hour period. This mode of operation is known as "standby" operation for the battery winterization equipment. During standby operation, it is desirable to charge the batteries in place from an external source through J15. In no case, after a long period of standby operation, should the heater be shut off or the batteries allowed to cool down without first recharging. The current drain of the heater is such that the batteries must have an external charge if on standby more than 12 hours.

CAUTION

In cold weather, keep the battery in a high state of charge to prevent freezing. Remove frozen batteries from the generator set immediately upon discovery to avoid damage caused by acid leaking from cracked cases when the battery thaws.

2-13. Operation in Extreme Heat

a. The generator set will operate satisfactorily at temperatures up to 125° F.

b. Lubricate in accordance with LO 5-6115-339-12.

c. The operation of the equipment in extreme heat increases the evaporation rate of water from the battery electrolyte. Check electrolyte level frequently.

2-14. Operation in Dusty or Sandy Areas

a. Erect protective shield for generator set. Dust and sand shorten life of equipment parts and cause mechanical failure. Utilize natural barriers. Wipe down unit at frequent intervals using approved cleaning solvent. If water is plentiful, wet down surrounding area beyond immediate operating area.

b. Lubricate in accordance with LO 5-6115-339-12. Clean oil tank screen and oil fill and level cap frequently to prevent dust and abrasive material from entering engine. Clean tank screen and oil fill and level cap before adding or changing oil.

c. Keep fuel supply tank cap tightly closed to prevent dust and sand from entering tank. Clean area around fuel supply tank cap before removing cap to add fuel. Keep all doors and covers closed as much as possible. When unit is not being used, keep enclosure cover assembly (fig. 1-1) in place.

2-15. Operation Under Rainy or Humid Conditions

a. The generator set has been weatherized to operate satisfactorily under rainy or humid conditions. However, special precautions should be observed to insure proper operation of the equipment and safety of personnel.

b. Secure all access panels and doors on generator set enclosure to minimize admittance of moisture.

c. Close and secure instrument panel protective door assembly (fig. 1-1) after generator set has been started and adjusted for operation to prevent accumulation of excessive moisture on engine and electrical controls instrument panel assemblies. Remove excess moisture from control panels with a clean dry cloth.

d. Lubricate in accordance with LO 5-6115-339-12.

e. When generator set is not in use, secure enclosure cover assembly (fig. 1-1) in place.

2-16. Operation in Salt Water Areas

a. Salt water has a corrosive action on metal. Prevention of rust and deterioration of electrical insulation in salt water areas requires constant exercise of preventive measures. Rust and corrosion at any point on the generator set must be corrected immediately.

b. Lubricate in accordance with LO 5-6115-339-12.

c. Wash down equipment regularly with fresh water. Avoid directing water hose or other high pressure water source into louvers on lower front panel assembly (fig. 1-1). Dry generator set and inspect all painted surfaces for cracked, peeled, or blistered paint. Coat all exposed surfaces with corrosive preventive paint.

2-17. Operation at High Altitudes

The generator set will operate satisfactorily without any special precautions to deliver 60 kw of power at elevations up to 8,000 feet.

Section VI. OPERATION OF MATERIEL USED IN CONJUNCTION WITH THE EQUIPMENT

2-18. Internal Combustion Battery Heater

a. Description. The internal combustion battery heater (fig. 4-13) provides heated air to the battery box assembly. Fresh air is drawn through the heater by an electrically driven fan and is ducted to the battery box assembly. The air is heated within the heater by circulating around a combustion chamber that is fired by engine fuel. The battery heater is energized through the winterization heater switch (fig. 2-4) on the electrical controls instrument panel and is regulated by a battery electrolyte temperature sensor located in one of the batteries. The sensor actuates a relay circuit which applies power to energize the solenoid coil of the heater pressure regulator valve (fuel valve), heater fuel pump, ignitor, and fan motor when the winterization heater switch is in the ON position and the battery electrolyte temperature decreases to approximately 0° F. A flame switch de-energizes the heater ignition system after initial combustion and the winterization heater lamp lights to indicate heater operation. When the battery electrolyte temperature increases to approximately 20° F., the sensor causes the heater to shut down. A manual reset limit switch on the heater and the winterization heater circuit breaker on the electrical controls instrument panel protect the heater electrical circuit.

b. Starting the Battery Heater.

(1) Check fuel supply to insure that adequate fuel is available for anticipated heater operating period.

(2) Open battery heater fuel shutoff valve (fig. 4-8).

(3) Press winterization heater circuit breaker (fig. 2-4) to insure that it is closed.

(4) Remove cap from one of the two battery heater external exhaust outlets.

(5) Press winterization heater lamp to insure it lights.

(6) Place winterization heater switch in ON position.

NOTE

The operation of battery heater is automatic when winterization heater switch is placed in the ON position. The winterization heater lamp lights when heater is operating. If heater does not, check to insure that the connector between the battery electrolyte temperature sensor (fig. 2-1) and temperature sensor electrical harness is secure and free of dirt, grease, and corrosion.

c. Stopping the Battery Heater. Place winterization heater switch in the OFF position.

NOTE

The battery heater will continue to operate for a short over-run period. This is due to the purging of fuel already in the heater at the time of shut down. Close heater fuel shutoff valve and replace cap on heater exhaust outlet if battery heater operation is not anticipated in the near future.

CHAPTER 3

OPERATOR / CREW MAINTENANCE INSTRUCTIONS

Section I. BASIC ISSUE ITEMS

Tools, equipment, and repair parts issued with or authorized for the generator set are listed in the basic issue items list, appendix C.

Section II. LUBRICATION INSTRUCTIONS

3-1. General Lubrication Information

a. Keep all lubricants in closed containers and store in a clean, dry place away from extreme heat. Allow no dust, dirt, or other foreign material to mix with lubricants. Keep all lubrication equipment clean and ready for use.

b. Keep all external parts not requiring lubrication clean of lubricants. Before lubricating equipment, wipe all lubrication points free of dirt and grease. Clean all lubrication points after lubrication to prevent accumulation of foreign matter.

c. Prior to operation of the generator set, visually check all points lubricated. Refer to paragraph 2-9 and start the equipment. Operate the set for five minutes and visually inspect all lubrication points for leaks or lack of proper lubrication. Refer to paragraph 2-10 and stop the generator set.

3-2. Detailed Lubrication Information

a. Oil Filter and Oil Tank Screen. Service the oil filter and the oil tank screen as shown in figure 3-1.

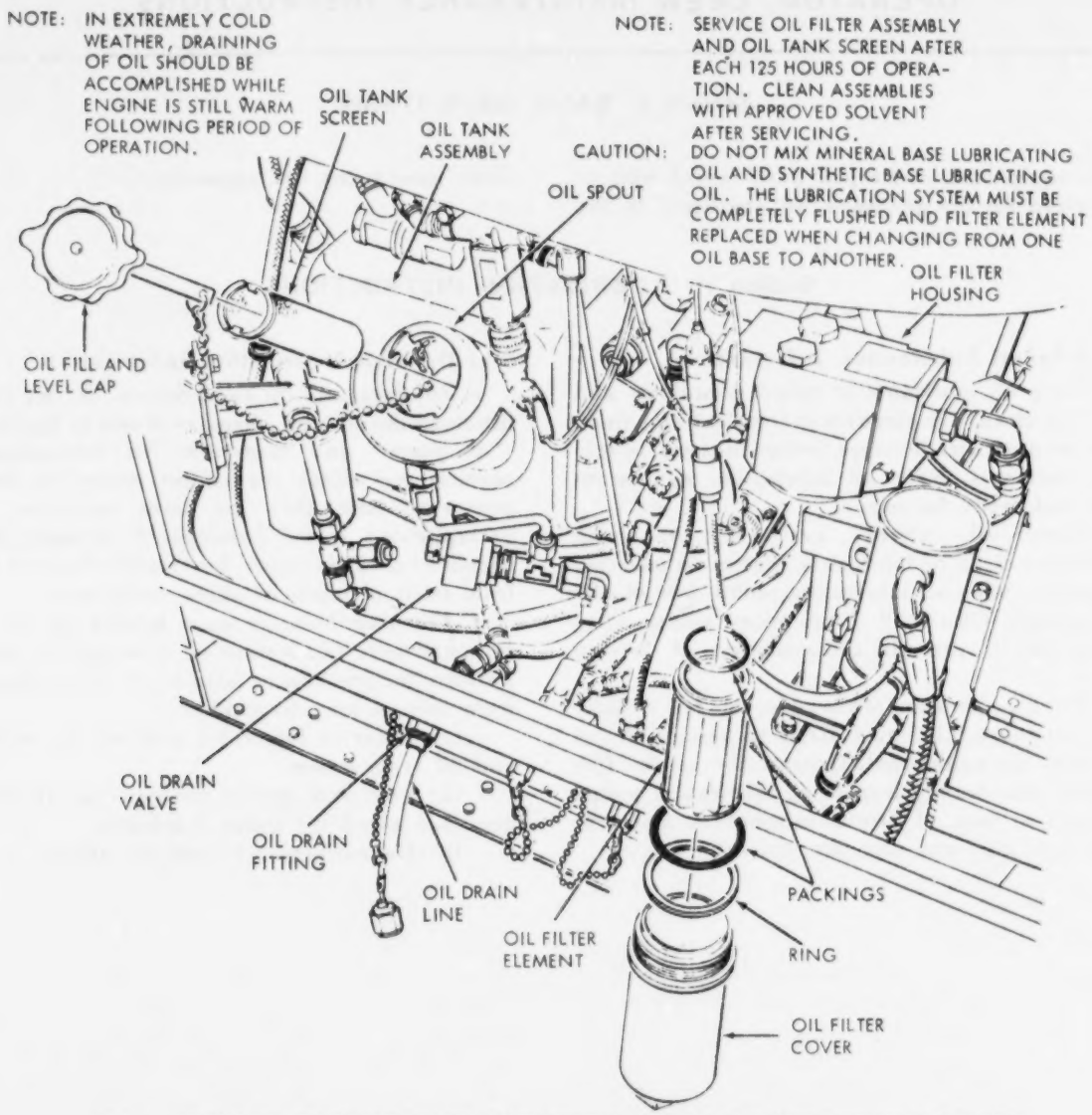
b. Starter and Generator. No lubrication is required on either the starter motor or the ac generator since they are both equipped with prelubricated sealed bearings. A periodic check should be made however, for excessive heat or noise from friction points of either component.

c. Flushing. Mineral base lubricating oil and synthetic base lubricating oil must not be mixed. Perform the procedures listed below when changing from one oil base to another.

(1) Refer to figure 3-1 and service oil filter and oil tank screen.

(2) Start and operate generator set at no-load governed speed for about 5 minutes.

(3) Repeat steps (1) and (2) above.


NOTE: IN EXTREMELY COLD WEATHER, DRAINING OF OIL SHOULD BE ACCOMPLISHED WHILE ENGINE IS STILL WARM FOLLOWING PERIOD OF OPERATION.
NOTE: SERVICE OIL FILTER ASSEMBLY AND OIL TANK SCREEN AFTER EACH 125 HOURS OF OPERATION. CLEAN ASSEMBLIES WITH APPROVED SOLVENT AFTER SERVICING.
CAUTION: DO NOT MIX MINERAL BASE LUBRICATING OIL AND SYNTHETIC BASE LUBRICATING OIL. THE LUBRICATION SYSTEM MUST BE COMPLETELY FLUSHED AND FILTER ELEMENT REPLACED WHEN CHANGING FROM ONE OIL BASE TO ANOTHER.
OIL TANK SCREEN
OIL TANK ASSEMBLY
OIL SPOUT
OIL FILTER HOUSING
OIL FILL AND LEVEL CAP
OIL DRAIN VALVE
OIL DRAIN FITTING
OIL DRAIN LINE
OIL FILTER ELEMENT
PACKINGS
RING
OIL FILTER COVER

STEP 1. INSTALL OIL DRAIN LINE ON OIL DRAIN FITTING. EXTEND LINE INTO SUITABLE CONTAINER.
STEP 2. REMOVE OIL FILL AND LEVEL CAP FROM OIL SPOUT. CLEAN OIL FILL AND LEVEL CAP WITH APPROVED SOLVENT AND DRY THOROUGHLY.
STEP 3. REMOVE OIL TANK SCREEN FROM OIL SPOUT. CLEAN SCREEN WITH APPROVED SOLVENT AND DRY THOROUGHLY. INSPECT SCREEN FOR CRACKS, ENLARGED HOLES, OR OTHER DAMAGE. REPLACE DEFECTIVE SCREEN.
STEP 4. OPEN OIL DRAIN VALVE AND ALLOW OIL TO DRAIN INTO CONTAINER. CLOSE VALVE WHEN OIL HAS DRAINED AND DISCONNECT OIL DRAIN LINE.
STEP 5. REMOVE OIL FILTER COVER FROM OIL FILTER HOUSING. REMOVE OIL FILTER ELEMENT AND PACKINGS AND CLEAN COVER WITH APPROVED SOLVENT. DRY COVER THOROUGHLY AFTER CLEANING.
STEP 6. INSTALL NEW OIL FILTER ELEMENT AND PACKINGS AND OIL FILTER COVER IN REVERSE ORDER OF REMOVAL PROCEDURE.
STEP 7. INSTALL OIL TANK SCREEN IN OIL SPOUT AND FILL OIL TANK AT SPOUT AS SPECIFIED IN **LO5-6115-339-12.**
STEP 8. INSTALL OIL FILL AND LEVEL CAP IN OIL SPOUT.

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Figure 3-1. Oil filter and oil tank screen service.

Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

3-3. General

To insure that the generator set is ready for operation at all times, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance checks and services to be performed are listed and described in paragraph 3-4.

3-4. Preventive Maintenance Checks and Services

a. This paragraph includes a tabulated listing of the preventive maintenance checks and services to be performed by the operator.

b. The item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the equipment will be noted for future correction, to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noted during operation which would damage the equipment if operation were continued. All deficiencies and shortcomings will be recorded together with the corrective action on DA Form 2404 at the earliest opportunity. Refer to table 3-1.

Table 3-1. Preventive Maintenance Checks and Services

B — Before Operation A — After Operation M — Monthly
D — During Operation W — Weekly Q — Quarterly

Item number	Interval: Operator: Daily B	Daily D	Daily A	Operator: W	Org.: M	Org.: Q	Item to be Inspected	Procedure	Reference
1			X				Fuel schedule vent fitting	Clean a clogged fitting. Insure cap is removed during operation of set.	(fig. 2-2)
2	X						Oil tank assembly	Check engine oil level and add oil as indicated by oil level mark on oil fill and level cap. Clean oil tank screen after 125 hours of operation.	(para 3-2)
3			X				Fuel tank fuel filter assembly,	Replace fuel tank fuel filter element after each 125 hours of operation.	(para 3-6)
4			X				Batteries	Tighten loose cables and mountings. Remove corrosion. Fill electrolyte to level indicated, or ½ inch above cell plates.	(para 2-11)

Section IV. TROUBLESHOOTING

3-5. General

This section contains information useful to the operator in correcting unsatisfactory operation of the equipment. Any malfunction that occurs that is beyond the scope of the operator will be referred to organizational maintenance personnel.

3-6. Troubleshooting

Malfunctions which may occur and can be resolved by the operator are listed in chart 3-1.

Chart 3-1. Troubleshooting

Malfunction	Probable Cause	Corrective Action
1. Main fuel pump and motor assembly fails to run	*a.* Internal DC circuit breaker tripped.	*a.* Reset circuit breaker.
	b. Battery cable disconnected or corroded	*b.* Connect battery cable, remove corrosion.
	c. Low-charged batteries	*c.* Check specific gravity of electrolyte (para 2-1).
2. Starter motor fails to run	*a.* Internal DC circuit breaker tripped.	*a.* Reset circuit breaker.
	b. Battery cable disconnected or corroded	*b.* Connect battery cable, remove corrosion.
	c. Low-charged batteries	*c.* Check specific gravity of electrolyte (para 2-1).
3. Engine turns over but combustion does not occur.	*a.* Low or depleted fuel supply.	*a.* Replenish fuel supply.
	b. Fuel schedule vent fitting capped or clogged.	*b.* Remove cap; use wire to clear clogged fuel schedule vent.
	c. Air in fuel system	*c.* Prime fuel system (para 2-9).
4. Engine shuts down immediately after combustion occurs	*a.* Low or depleted fuel supply	*a.* Replenish fuel supply.
	b. Fuel tank fuel filter clogged	*b.* Replace filter element (para 3-8).
5. Engine does not accelerate or accelerates too slowly	*a.* Low or depleted fuel supply.	*a.* Replenish fuel supply.
	b. Low-charged batteries	*b.* Check specific gravity of electrolyte (para 2-1).
	c. Fuel tank filter partially clogged	*c.* Replace filter element (para 3-8).
	d. Air in fuel system	*d.* Prime fuel system (para 2-9).
6. Erratic engine acceleration or operation or inability to carry load	*a.* Contamination in fuel supply	*a.* Drain and replenish fuel supply.
	b. Fuel tank fuel filter partially clogged	*b.* Replace filter element (para 3-8).
	c. Air in fuel system.	*c.* Prime fuel system (para 2-9).
7. Engine accelerates to governed rpm or less and stops	Low or depleted oil supply	Replenish oil supply to proper level (LO 5-6115-339-12).
8. Governed engine rpm is more than 103 percent	Frequency Adj screw set too high	Adjust frequency adj screw (fig. 2-4) counterclockwise for indication on frequency meter of 400±1 cps.
9. Smoke or flame emitted from muffler assembly during acceleration	Oil tank assembly overfilled	Drain oil to proper level.
10. Engine shuts off during operation	*a.* Low or depleted fuel supply	*a.* Replenish fuel supply.
	b. Low or depleted oil supply	*b.* Replenish oil supply to proper level (LO 5-6115-339-12).
	c. Fuel tank fuel filter clogged	*c.* Replace filter element (para 3-8).
11. Frequency cannot be adjusted	Internally wired plug not installed in remote control receptacle J14.	Install plug.
12. Voltmeter does not indicate voltage when engine is operating at governed speed	*a.* Voltage Adj screw in full clockwise position causing overvoltage condition	*a.* Adjust voltage adj screw (fig. 2-4) for required ac generator output.
	b. Over voltage relay tripped open	*b.* Momentarily place over voltage reset in up position to reset over voltage circuit.

Chart 3-1. Troubleshooting—Continued.

Malfunction	Probable Cause	Corrective Action
13. Over voltage lamp illuminates when main circuit breaker is placed in closed position.	*a.* Internally wired plug not installed in Remote Control receptacle J14 and Remote-Local Control Selector switch in Remote position	*a.* Place switch in local position and securely install wired plug in J14. Momentarily place main circuit breaker in closed position.
	b. Remote-Local Voltage Sensing Selector switch in Remote position when remote voltage sensing is not employed	*b.* Place Remote-Local Voltage sensing selector switch in local position.
	c. Voltage Adj screw in full clockwise position	*c.* Adjust voltage adj screw for required ac generator output voltage.
14. Voltage droop cannot be adjusted	Unit-Parallel switch in Unit position	Place unit-parallel switch in parallel position.
15. Frequency droop cannot be adjusted	Unit-Parallel switch in Unit position	Place unit-parallel switch in parallel position.
16. Parallel generator sets will not synchronize or stay in synchronization	*a.* Unit-Parallel switch in Unit position	*a.* Place unit-parallel switch in parallel position.
	b. Reactive voltage droop rheostat (R7) not properly adjusted	*b.* Adjust reactive voltage rheostat (para 2-3*t*.
	c. Frequency droop rheostat (R6) not properly adjusted	*c.* Adjust frequency droop rheostat (para 2-3*t*.
17. Battery heater does not operate	*a.* Winterization Heater circuit breaker open	*a.* Reset (press) winterization heater circuit breaker.
	b. Heater over temperature limit switch tripped	*b.* Reset (press) heater over-temperature limit switch.
	c. Loose connection at battery electrolyte temperature sensor	*c.* Tighten connection.
18. Battery heater blower operates but combustion does not occur	*a.* Heater fuel shutoff valve closed	*a.* Open heater fuel shutoff valve.
	b. Low or depleted fuel supply	*b.* Replenish fuel supply.
19. Heater combustion occurs then goes out	Low or depleted fuel supply	Replenish fuel supply.

Section V. MAINTENANCE OF ENGINE ASSEMBLY

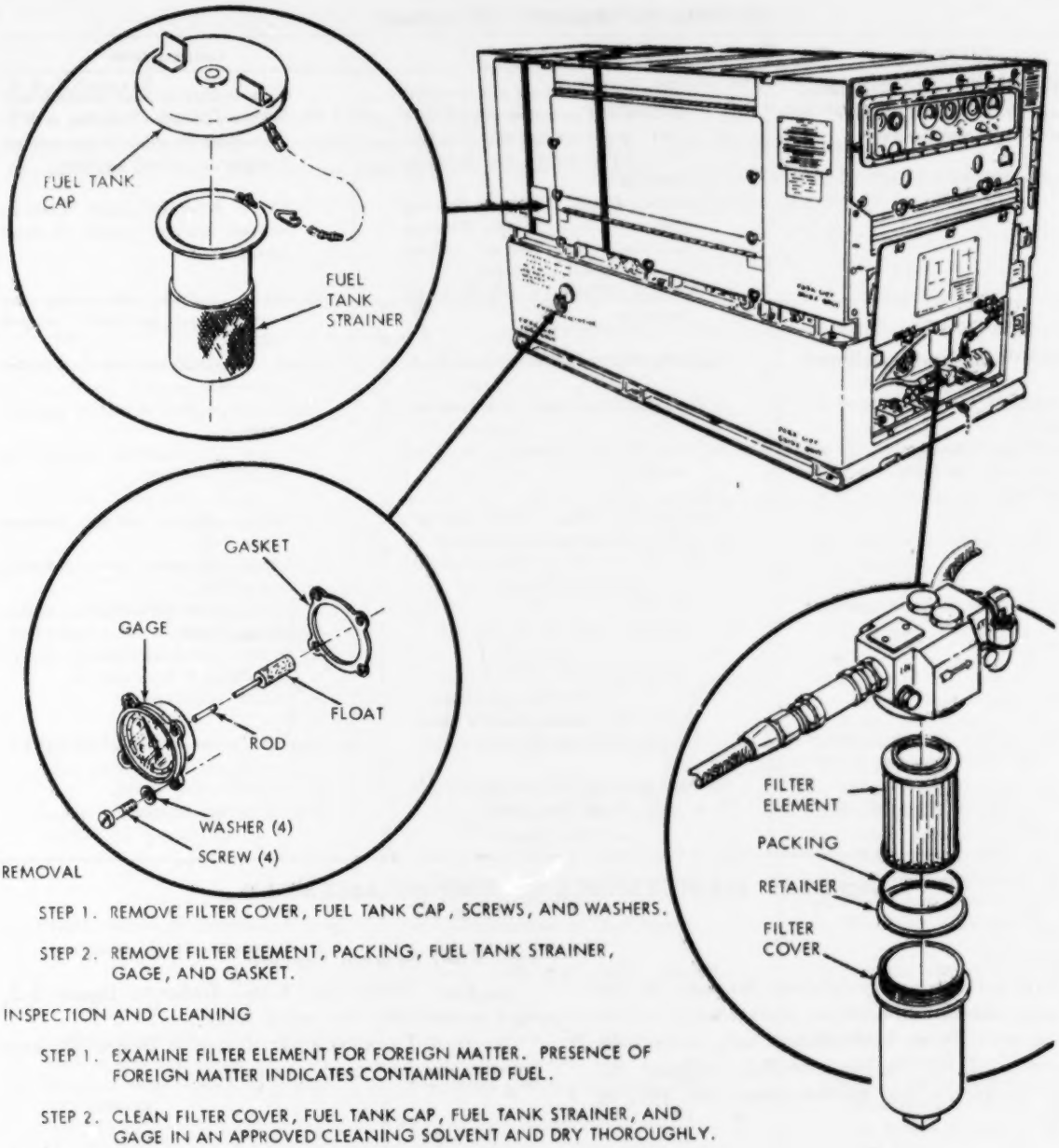
3-7. General

These instructions are published for use of the operator in assisting him in the maintenance of the generator set. These instructions only cover the maintenance of the engine assembly because the operator performs no maintenance on the ac generator.

3-8. Fuel System Service

a. Fuel Tank Fuel Filter. Refer to figure 3-2, and service the fuel tank filter.

b. Fuel Tank Strainer. Refer to figure 3-2 and service the fuel tank strainer.



REMOVAL

STEP 1. REMOVE FILTER COVER, FUEL TANK CAP, SCREWS, AND WASHERS.

STEP 2. REMOVE FILTER ELEMENT, PACKING, FUEL TANK STRAINER, GAGE, AND GASKET.

INSPECTION AND CLEANING

STEP 1. EXAMINE FILTER ELEMENT FOR FOREIGN MATTER. PRESENCE OF FOREIGN MATTER INDICATES CONTAMINATED FUEL.

STEP 2. CLEAN FILTER COVER, FUEL TANK CAP, FUEL TANK STRAINER, AND GAGE IN AN APPROVED CLEANING SOLVENT AND DRY THOROUGHLY.

INSTALLATION

STEP 1. INSTALL NEW FILTER ELEMENT, PACKINGS AND GASKET. REPLACE FUEL TANK CAP, STRAINER, AND GAGE, IN REVERSE ORDER OF REMOVAL.

STEP 2. OPERATE ENGINE FOR 5 MINUTES AND CHECK FUEL FILTER FOR LEAKAGE.

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Figure 3-2. Fuel tank fuel filter, fuel tank strainer and fuel gage.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF MATERIAL

4-1. Inspecting and Servicing

Refer to paragraph 2-1 for information on inspecting and servicing this equipment.

4-2. Installation

a. Refer to paragraph 2-2 for information on installing the generator set.

b. If conditions requires, connect a drain line to the plenum drain fitting (fig. 4-1). Extend the drain line into a suitable container. This connection must not be blocked or capped

c. If conditions warrant it, connect a drain to the muffler drain (fig. 4-1) and extend the line to a suitable container.

d. If the battery heater is to be operated with the auxiliary fuel tank attached, remove the cap from the heater external exhaust outlet (fig. 4-2) on left side of generator set. If the battery heater is to be operated without the auxiliary fuel tank attached, remove the cap from the heater external outlet at the bottom of the generator set.

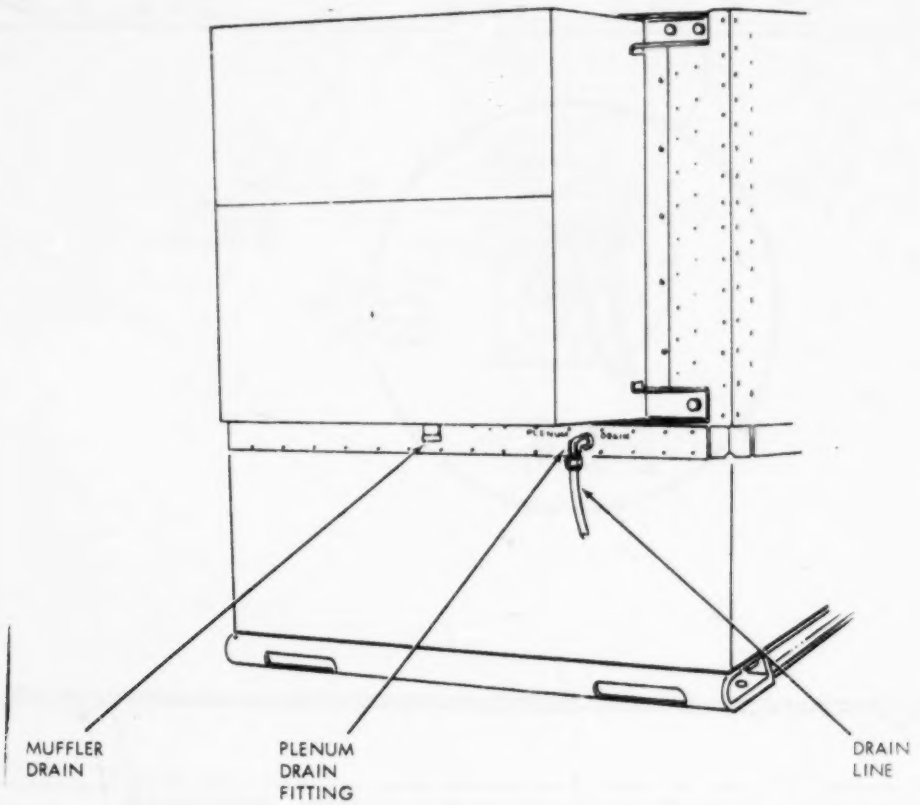

Figure 4-1. Plenum drain and muffler drain fittings.

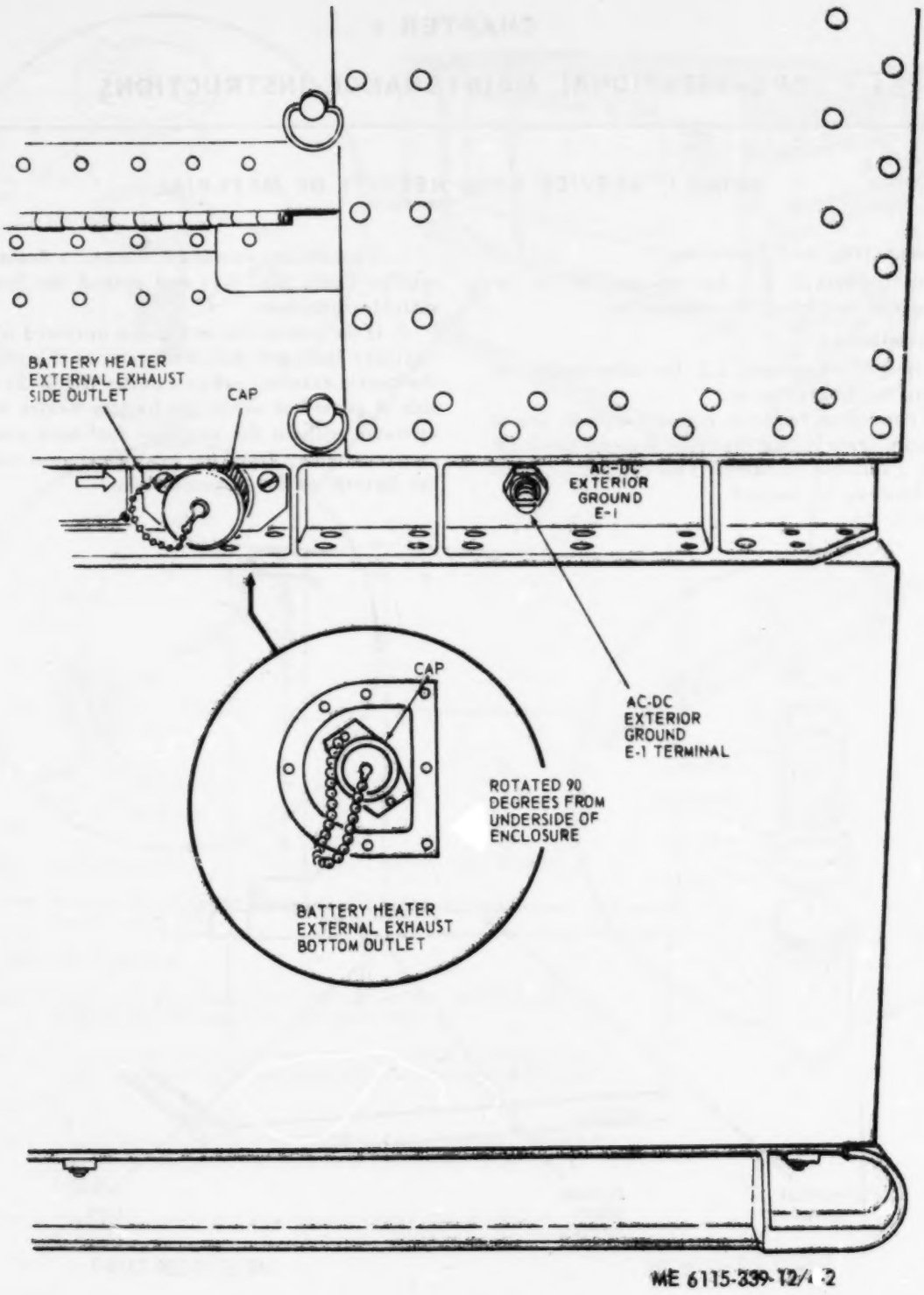

Figure 4-2. Battery heater external exhaust outlets and ground terminal connection.

Section II. REPAIR PARTS, SPECIAL TOOLS, AND EQUIPMENT

4-3. Tools and Equipment

Tools, equipment, and repair parts issued with or authorized for the generator set are listed in the basic issue items list, appendix C.

4-4. Special Tools and Equipment

a. The only special tool required by organizational maintenance personnel to maintain the generator set is shown in figure 4-3.

b. The adjustable beam-type sling (part number 281514-1), is a multiple leg sling with four lifting hooks attached to each end through chain links, and an adjustable lifting ring. The lifting hooks attach to the four hoist assemblies of the generator set enclosure for lifting the entire generator set.

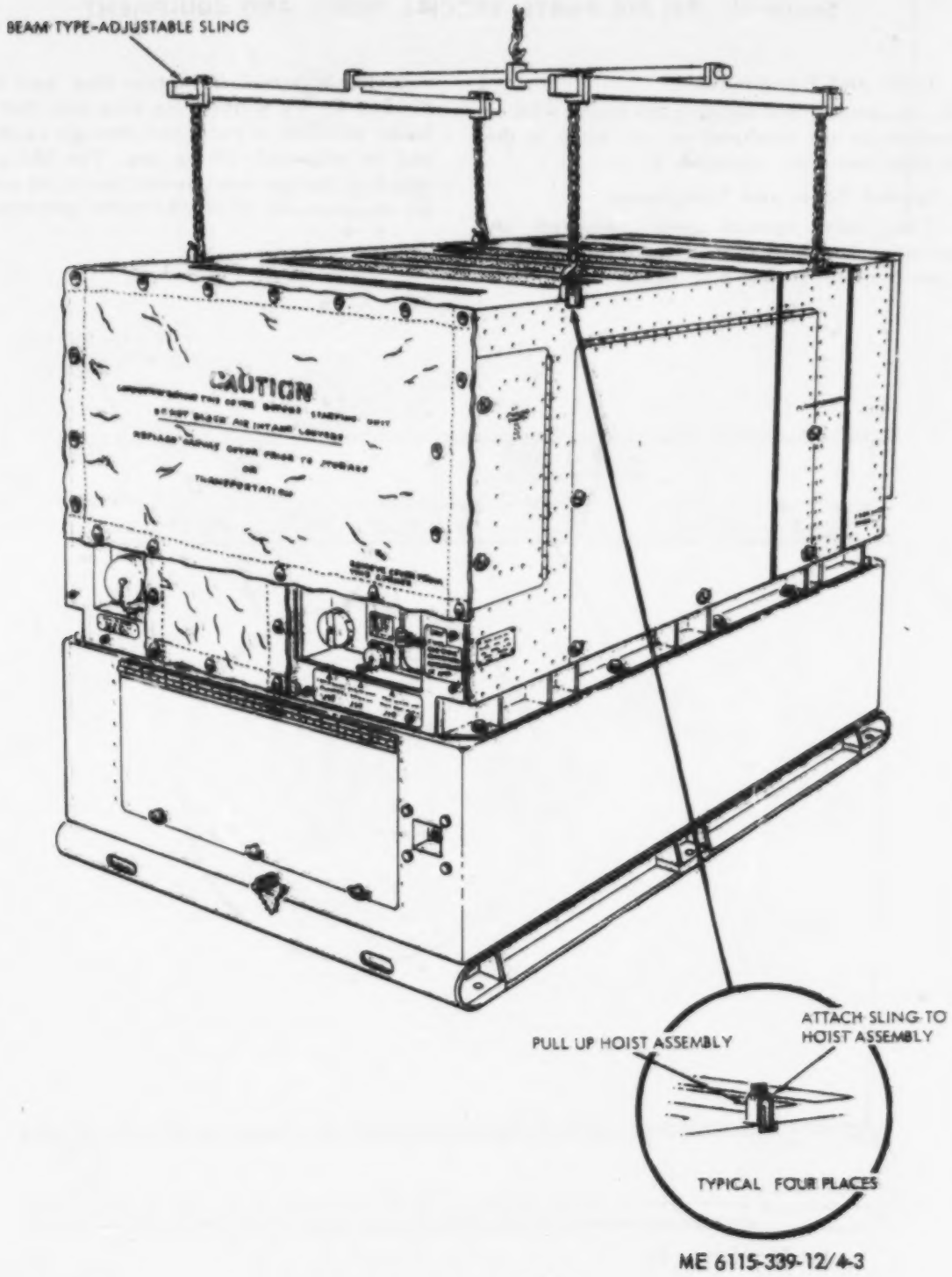

Figure 4-3. Generator set hoist assembly.

4-5. Maintenance Repair Parts

Repair parts and equipment are listed and illustrated in the Repair Parts and Special Tools List, TM 5-6115-339-20P.

Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

This section contains a tabulated listing of the preventive maintenance checks and services which are to be performed by organizational maintenance personnel. Refer to table 4-1.

Table 4-1. Preventive Maintenance Checks and Services

B — Before Operation A — After Operation M — Monthly
D — During Operation W — Weekly Q — Quarterly

Item number	Interval: Operator/Crew Daily B	Daily D	Daily A	W	Org. M	Org. Q	Item to be Inspected	Procedure	Reference
1						X	Enclosure Doors and Panels	Inspect for damaged seals.	(para 4-55)
2						X	Fuel Control Unit	Tighten or replace loose mounting screws and nuts. Carefully check for leaks while the generator set is running. Tighten a leaking fuel line connection.	(para 4-19)
3						X	Starter Motor Assembly	Tighten or replace loose electrical connections and mounting nuts. Replace worn, frayed, or otherwise damaged starter cables. Replace a defective starter motor assembly.	(para 4-35)
4						X	Oil Tank Assembly	Inspect for damage or oil leakage. Replace defective oil and air vent lines. Replace a damaged oil fill and level cap or oil tank screen.	(para 4-32)
5						X	Oil Drain Valve	Replace a damaged or leaking oil drain valve. Replace a leaking or damaged oil line. Tighten loose oil line connection.	(para 4-31)
6						X	Fuel Solenoid Valve	Tighten or replace loose or missing mounting screws and nuts. Inspect for leakage, cracks, or other physical damage. Replace a leaking or damaged fuel line. Tighten a leaking fuel line connection. Tighten loose electrical connection. Replace a defective fuel solenoid valve.	(para 4-27)
7						X	Main Fuel Filter Assembly.	Tighten or replace loose or missing mounting screws and nuts. Replace a defective or damaged fuel filter assembly. Replace a damaged or leaking fuel line.	(para 4-26)
8						X	Igniter Plug Assembly	Replace a worn frayed, or broken igniter plug electrical lead assembly. Tighten or replace loose or missing mounting screws. Clean dirty insulators. Replace an igniter plug with broken insulators or other damage.	(para 4-38)
9						X	Fuel Atomizer Assembly	Inspect for leaks or evidence of physical damage. Tighten or replace loose or missing mounting screws. Inspect for carbon deposits. Operate engine and inspect for excessive smoke from muffler assembly. Remove carbon deposits. Replace a defective assembly.	(para 4-28)
10						X	Combustion Chamber Assembly.	Inspect combustor cap for dents, cracks or other damage. Replace a cracked, hardened, or broken gasket. Replace a damaged or broken clamp. Replace a defective cap assembly. Inspect the chamber for cracks over ¼ inch in length and for dents, buckling, excessive wear and reduced thickness, and other evidence of deformation. Check every 125 hours. Replace a defective combustion chamber.	(para 4-51)
11							Exhaust Muffler Assembly	Tighten or replace loose or missing bolts and screws. Inspect for cracks or other physical damage. Clean a clogged muffler drain fitting. Replace a defective muffler assembly or screen.	(para 4-53)

Table 4-1. Preventive Maintenance Checks and Services—Continued

B — Before Operation A — After Operation M — Monthly
D — During Operation W — Weekly Q — Quarterly

Item number	Interval: Operator: Daily: B	Interval: Operator: Daily: D	Interval: Operator: Daily: A	Interval: Operator: W	Interval: Org.: M	Interval: Org.: Q	Item to be Inspected	Procedure	Reference
12							Turbine Exhaust Flange Assembly	Tighten or replace loose or missing screws. Inspect for cracks or other physical damage. Replace a defective turbine exhaust flange assembly. Inspect exhaust ejector assembly and clamp.	(para 4-53)
13						X	Oil Cooler	Tighten or replace loose or missing mounting bolts and nuts. Carefully check for leaks while generator set is running. Replace a defective oil cooler.	(para 4-33)
14							Main Fuel Pump and Motor Assembly	Tighten or replace loose or missing mounting screws. Inspect motor brushes. Replace worn or defective brushes. Tighten a leaking fuel line connection.	(para 4-25)
15							Air Inlet Screen	Tighten or replace loose or missing screws. Remove debris or other foreign matter. Replace defective gasket. Replace a defective air inlet screen.	(para 4-50)
16						X	Oil Pump Assembly	Inspect for cracks, breaks, oil leakage or other damage.	
17						X	Cooling Air Hoses	Tighten loose clamps. Inspect duct connections for breaks or other damage. Operate generator set and inspect hoses for leaks. Replace a defective hose.	(para 4-50)
18							Battery Heater	Tighten or replace loose or missing screws or duct clamp. Tighten loose electrical connections. Inspect heater exhaust ducts for leaks, breaks, or other damage. Replace a defective heater.	(para 4-57)
19						X	Battery Heater Fuel Filter Assembly	Tighten loose fuel line connector. Replace a leaking or damaged fuel line. Inspect cover and housing for leaks, cracks, dents, or other damage. Replace a defective cover or housing.	(para 4-59)
20						X	Start Relay	Tighten or replace loose or missing mounting screws and nuts. Tighten loose electrical connections. Inspect for cracks, dents, or other damage. Replace a defective relay.	(para 4-36)
21						X	Fuel Tank Filter Assembly	Tighten or replace loose or missing mounting hardware. Replace a damage fuel filter assembly.	(para 4-24)
22						X	Electrical Controls Instruments Panel Assembly	Tighten or replace loose or missing mounting screws, nuts, or knobs. Inspect controls and instruments for damage. Tighten or solder loose electrical connections. Replace a damaged or defective instrument.	(para 4-41)
23						X	Battery Electrolyte Temperature Sensor q	Clean sensor and electrical connection. Tighten loose connection.	(para 4-61)
24						X	Batteries	Test specific gravity of each cell. Replace a leaking or defective battery or defective battery cable.	(para 4-44)
25						X	Battery Box Assembly	Replace bent or damaged battery box tie-down rods hardware. Inspect battery box for damage. Replace a damaged box.	(para 4-46)
26						X	Battery Heater Electric Fuel Pump	Tighten or replace loose or missing mounting screws or nuts. Inspect for leaks, cracks, or other damage. Replace a defective pump.	(para 4-58)

Table 4-1. Preventive Maintenance Checks and Services—Continued

B — Before Operation A — After Operation M — Monthly
D — During Operation W — Weekly Q — Quarterly

Item No.	Interval: Operator: Daily: B	Interval: Operator: Daily: D	Interval: Operator: Daily: A	Interval: Operator: W	Interval: Org.: M	Interval: Org.: Q	Item to be Inspected	Procedure	Reference
27							Battery Heater Fuel Shut-Off Valve	Inspect for leakage, cracks, or other damage. Replace a leaking or damaged fuel line. Replace a defective valve.	(para 4-60)

Section IV. TROUBLESHOOTING

This section contains information useful to organizational maintenance personnel in diagnosing and correcting malfunctions in the equipment. The information is presented in tabular form as shown in chart 4-1.

Chart 4-1. Troubleshooting

Malfunction	Probable Cause	Corrective Action
1. Main fuel pump and motor assembly fails to run.	*a.* Internal dc circuit breaker defective	*a.* Replace circuit breaker (para 4-41).
	b. Battery defective	*b.* Replace (fig. 2-1).
	c. Master switch defective.	*c.* Replace (para 4-40).
	d. Remote-local control selector switch defective.	*d.* Replace (para 4-41).
	e. Main fuel pump and motor assembly defective.	*e.* Replace (para 4-25).
2. Auxiliary fuel pump and motor assembly fails to run.	Auxiliary fuel pump and motor assembly defective	Replace (para 4-21).
3. Starter motor fails to run.	*a.* Internal dc circuit breaker defective	*a.* Replace (para 4-41).
	b. Battery defective	*b.* Replace (fig. 2-1).
	c. Master switch defective.	*c.* Replace (para 4-40).
	d. Remote-local control selector switch defective	*d.* Replace (para 4-41).
	e. Starter cables defective.	*e.* Replace (para 4-48).
	f. Start relay defective	*f.* Check for start relay actuation by sound or feel when Master switch is placed in the START position; use 24-volt test light or dc voltmeter and check for voltage at terminal X1 on start relay when Master switch is in START position. Replace a defective relay (para 4-36).
	g. Defective starter motor assembly.	*g.* Replace (para 4-35).
4. Starter motor runs but does not rotate engine.	Defective starter motor assembly.	Replace (para 4-35).
5. Engine stops motoring when master switch is released from start position.	Defective master switch	Replace (para 4-40).
6. Starter motor fails to shut off when engine rpm increases to 35%.	Defective start relay	Replace (para 4-36).
7. Engine turns over but combustion does not occur	*a.* Defective battery	*a.* Replace (para 2-1).
	b. Fuel atomizer assembly clogged or defective.	*b.* Clean screen (para 4-28).
	c. Fuel control unit fuel filter clogged.	*c.* Replace filter element (para 4-19).
	d. Main fuel filter clogged.	*d.* Replace filter element (para 4-19).
	e. Main fuel pump and motor assembly defective.	*e.* Replace (para 4-25).
	f. Auxiliary fuel pump and motor assembly defective.	*f.* Replace (para 4-21).
8. Engine shuts down immediately after combustion occurs.	*a.* Fuel atomized assembly clogged.	*a.* Clean screen (para 4-28). Replace assembly (para 4-28).
	b. Main fuel filter clogged	*b.* Replace element (para 4-19).
	c. Fuel control unit fuel filter clogged.	*c.* Replace filter element (para 4-19).
	d. Fuel solenoid valve defective.	*d.* Replace (para 4-27).
9. Engine does not accelerate or accelerates too slowly.	*a.* Defective battery	*a.* Replace (para 2-1).
	b. Fuel atomizer assembly clogged.	*b.* Clean screen (para 4-28). Replace assembly (para 4-28).
	c. Fuel control unit clogged.	*c.* Replace filter element (para 4-19).
	d. Main fuel filter clogged.	*d.* Replace filter element (para 4-19).
	e. Fuel solenoid valve defective.	*e.* Replace (para 4-27).

Chart 4-1. Troubleshooting—Continued

Malfunction	Probable Cause	Corrective Action
10. Erratic engine acceleration or operation or inability to carry load.	*a.* Fuel atomizer assembly clogged	*a.* Clean screen (para 4-28). Replac assembly (para 4-28).
	b. Fuel control unit fuel filter clogged.	*b.* Replace filter element (para 4-19).
	c. Main fuel filter clogged.	*c.* Replace element (para 4-19).
	d. Thermostat bypass solenoid valve defective.	*d.* Replace valve (para 4-27).
	e. Main fuel pump and motor assembly defective.	*e.* Replace (para 4-25).
	f. Auxiliary fuel pump and motor assembly defective.	*f.* Replace (para 4-21).
11. Engine accelerates to governed rpm or less and shuts down.	Defective internal dc circuit breaker.	Replace (para 4-40).
12. Low oil pressure.	*a.* Oil filter element dirty.	*a.* Replace (fig. 3-1).
	b. Oil pressure gage or hose assembly defective.	*b.* Replace gage and/or hose assembly (para 4-40).
13. High oil pressure	Oil pressure gage defective.	Replace (para 4-40).
14. High oil temperature	Oil cooler air duct obstructed	Remove obstruction.
15. Engine shuts off during operation.	*a.* Main fuel filter clogged.	*a.* Replace element (para 4-19).
	b. Fuel control unit fuel filter clogged	*b.* Replace filter element (para 4-19).
	c. Fuel atomizer screen clogged	*c.* Clean screen (para 4-28). Replace defective atomizer assembly (para 4-28).
	d. Fuel solenoid valve defective	*d.* Replace (para 4-27).
	e. Main fuel pump and motor assembly defective.	*e.* Replace (para 4-25).
16. Frequency cannot be adjusted.	Frequency adjust potentiometer defective.	Replace (para 4-41).
17. Voltmeter does not indicate voltage when engine is operating at governed speed.	*a.* Volt-Amp selector switch defective	*a.* Replace (para 4-41).
	b. Voltmeter defective	*b.* Replace (para 4-41).
18. Voltage cannot be adjusted	Voltmeter defective.	Replace (para 4-41).
19. Main circuit breaker lamp remains lit when main circuit breaker switch is in the open position.	Defective main circuit breaker switch	Replace switch (para 4-41).
20. Battery heater does not operate	*a.* Defective winterization heater circuit breaker.	*a.* Replace circuit breaker (para 4-41).
	b. Winterization heater switch defective.	*b.* Replace switch (para 4-41).
	c. Defective heater overtemperature limit switch.	*c.* Replace switch (para 4-41).
	d. Defective battery	*d.* Replace (para 2-1).
	e. Defective battery heater.	*e.* Replace (para 4-57).
21. Battery heater blower operates but combustion does not occur.	*a.* Heater fuel pump defective.	*a.* Replace (para 4-58).
	b. Defective battery	*b.* Replace (fig. 2-1).
22. Heater combustion occurs then goes out.	Heater fuel pump defective.	Replace (para 4-58).
23. Heater combustion surges.	Defective heater fuel pump.	Replace (para 4-58).
24. Heater fails to shut down when winterization heater switch is placed in OFF position.	Defective switch	Replace (para 4-41).

Section V. RADIO INTERFERENCE SUPPRESSION

4-6. General Methods Used to Attain Proper Suppression

Essentially, suppression is attained by providing a low resistance path to ground for stray currents. The methods used include shielding the ignition and high-frequency current carrying wires, grounding the frame with bonding straps, and using capacitors and resistors.

4-7. Interference Suppression Components

a. Primary Suppression Components. The primary suppression components are listed in table 4-2 and illustrated in figure 4-4.

b. Secondary Suppression Components. These components have radio interference suppression functions which are incidental and / or secondary to their primary function.

Table 4-2. Interference Suppression Components

Qty	Component	Size	Type
2	Capacitor	0.1 UF, 500V AC-DC	Bypass
1	Capacitor	0.01 UF, 100 V DC	Bypass
1	Capacitor	0.25 UF, 100V DC	Feed-through
2	Capacitor	0.5 UF, 100V DC	Feed-through
1	Capacitor	0.005 UF, 600V DC	Bypass
1	Bond strap	½ x 6"	Tinned copper braid
1	Tubular shielding	½ x 6"	Tinned copper braid

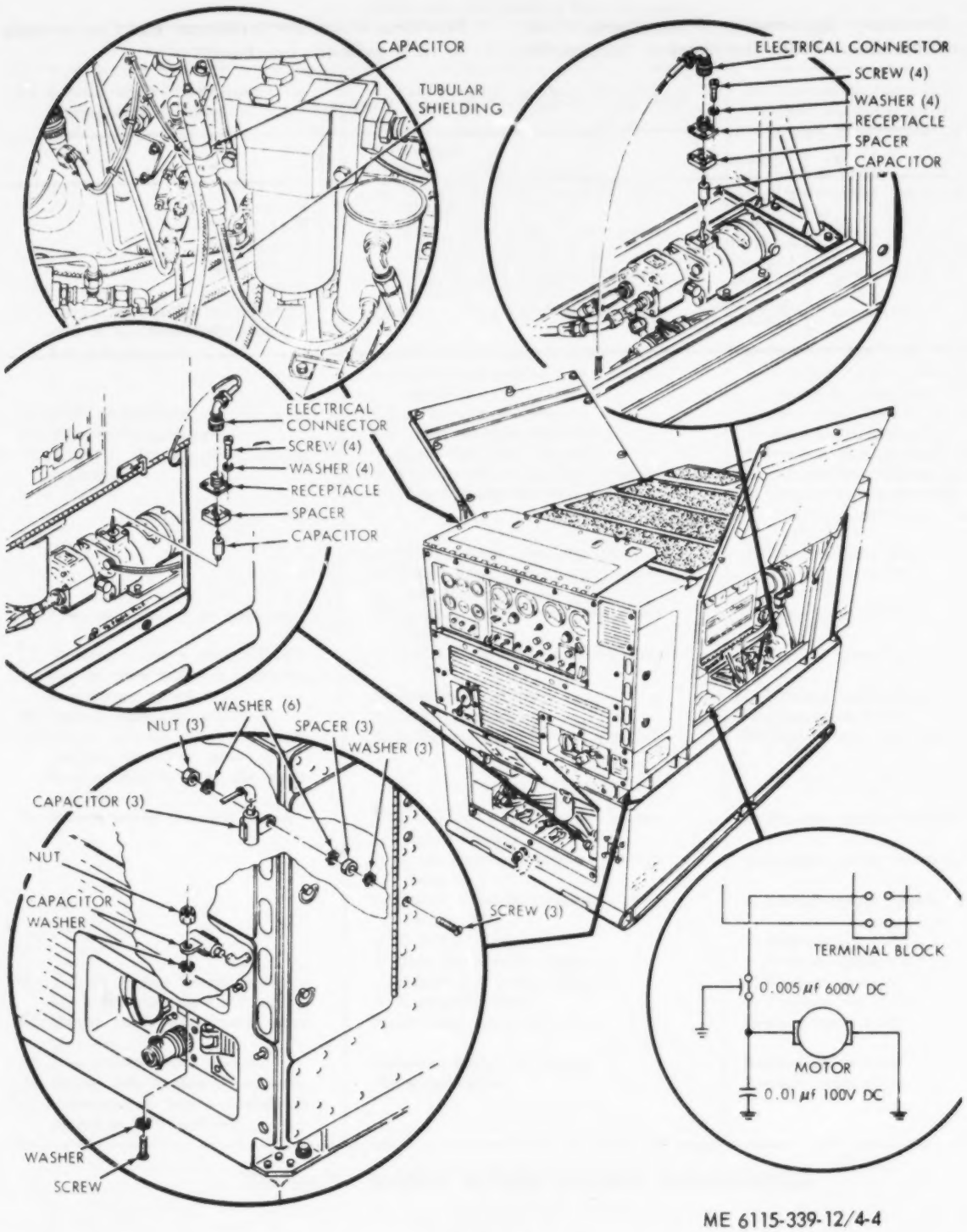

Figure 4-4. Interference suppression components.

4-8. Replacement of Suppression Components

Refer to figure 4-4 to replace the radio suppression components.

4-9. Testing of Radio Interference Suppression Components

Test the capacitors for leaks and shorts on a capacitor tester; replace defective capacitors. If test equipment is not available and interference is indicated, isolate the cause of interference by the trial-and-error method of replacing each capacitor in turn until the cause of interference is located and eliminated.

Section VI. MAINTENANCE OF THE GENERATOR SET

4-10. General

a. This section and subsequent sections will provide the necessary information for organizational maintenance personnel to adequately maintain the generator set.

b. The major components and systems of the generator set are the gas turbine engine, fuel system, electrical system, controls and instruments, winterization equipment, and the enclosure assembly. Each will be discussed in this and subsequent sections.

4-11. Gas Turbine Engine

The gas turbine engine (fig. 4-5) is a lightweight, compact engine, complete with all accessories necessary for operation. The turbine engine consists basically of a turbine section, compressor section, accessory section, fuel system, lubrication system, and electrical system.

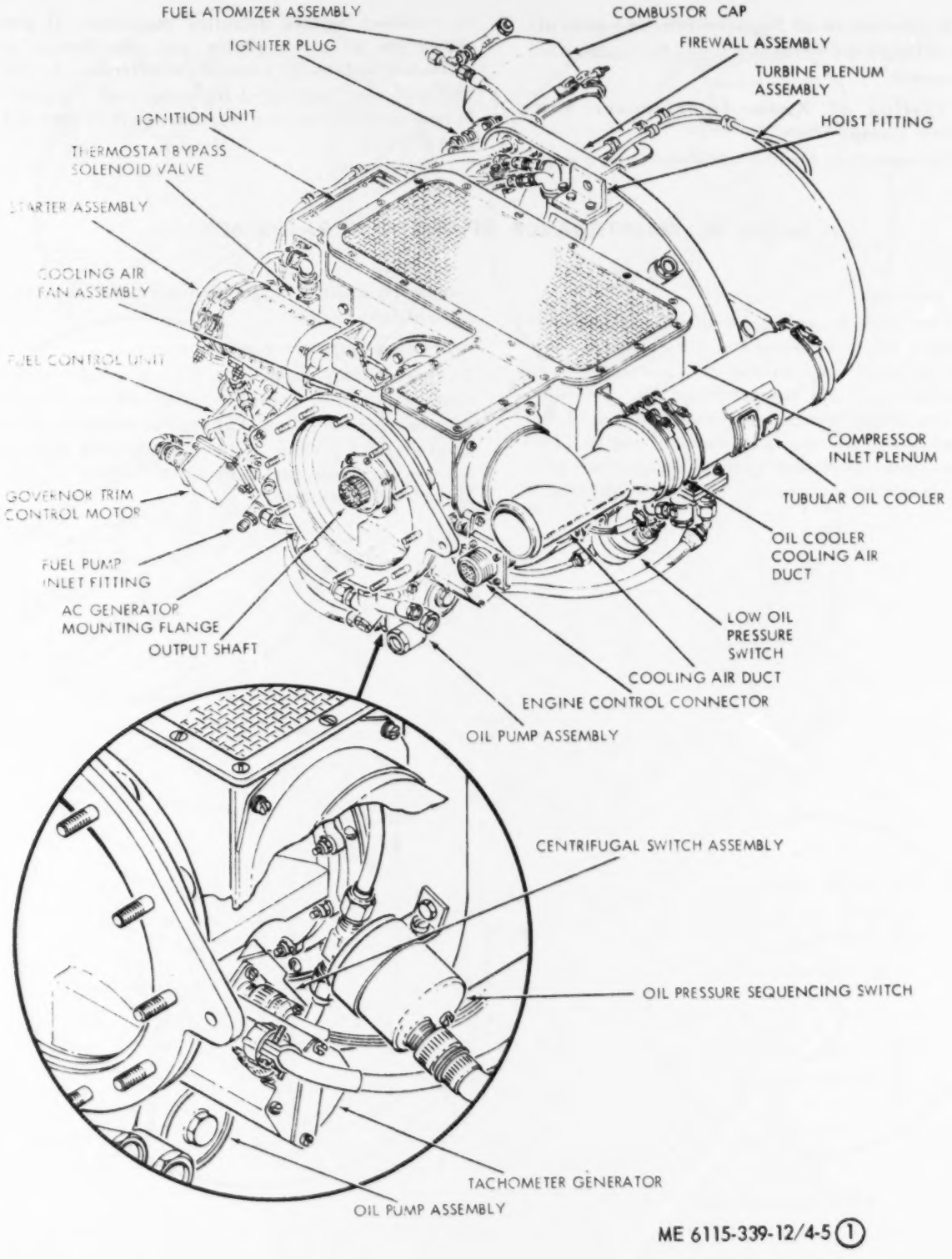

Figure 4-5. Gas turbine engine (sheet 1 of 2).

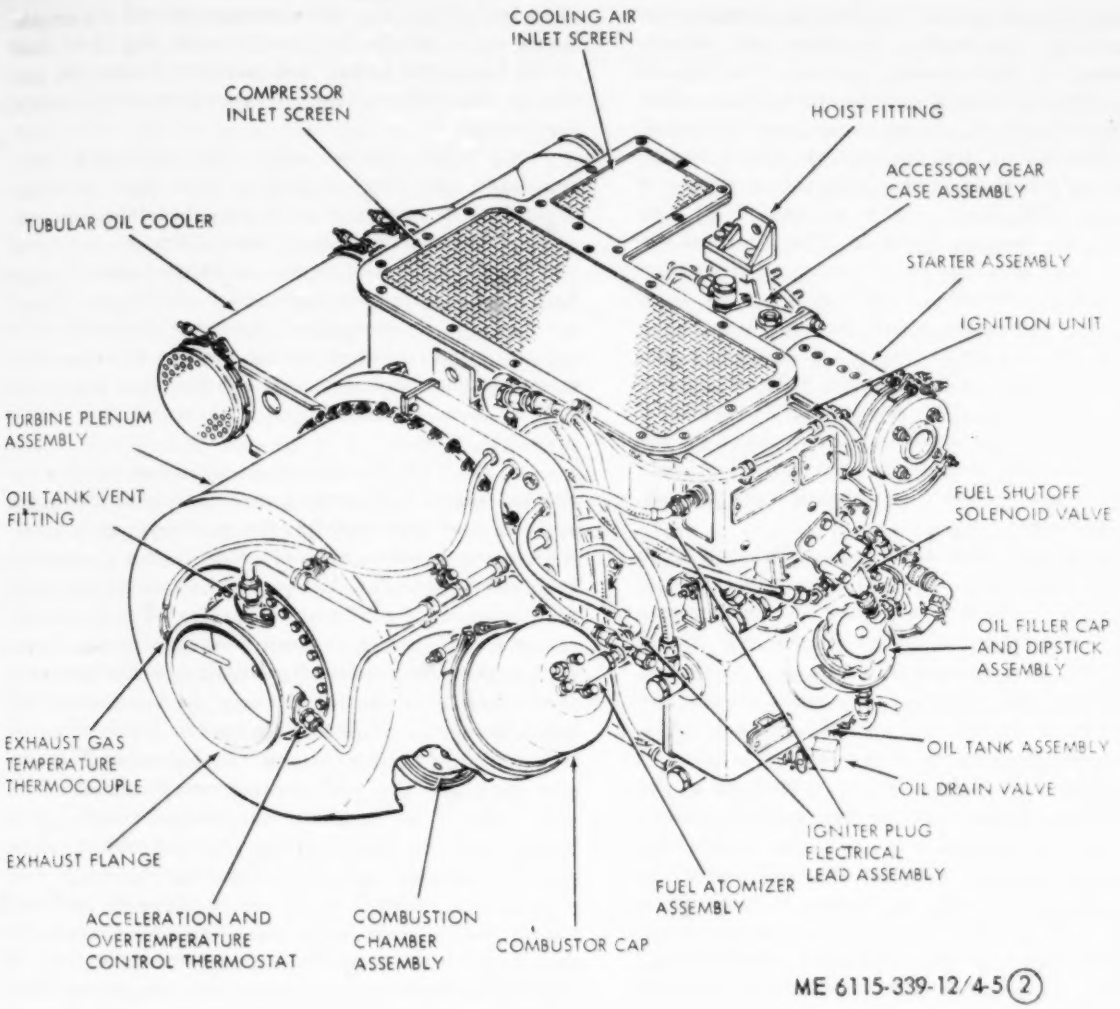

Figure 4-5. Gas turbine engine (sheet 2 of 2).

a. Turbine Section. The turbine section utilizes a radial inward flow turbine wheel to convert the energy of burning gases to rotational mechanical energy. A portion of the power developed by the turbine wheel is utilized to drive the compressor and engine accessories, the remainder is available for output-shaft power to the ac generator. The turbine section consists of the turbine plenum assembly, combustor cap, combustion chamber assembly, and turbine assembly.

(1) *Turbine plenum assembly.* The turbine plenum assembly (fig. 4-5) is a receiving chamber for compressor discharge air and encloses the turbine assembly and combustion chamber assembly.

(2) *Combustor cap.* The combustor cap is mounted on the turbine plenum assembly and provides support and mounting provisions for the fuel atomizer assembly, igniter plug, and combustion chamber assembly.

(3) *Combustion chamber assembly.* The combustion chamber assembly is secured to the combustor cap and is enclosed by the turbine plenum assembly. The combustion chamber is a reverse-flow single tube-type with openings in the tube wall to admit compressed air from the chamber formed by the turbine plenum assembly. The fuel atomizer assembly nozzle at the upper end of the tube sprays fuel into the combustion area for mixture with the compressed air. Initial ignition of the fuel mixture is provided by the igniter plug which protrudes through the side of the tube. Combustion is self sustained until fuel flow is shut off. The lower or outlet end of the combustion chamber assembly mates with an opening in the tube assembly torus.

(4) *Turbine assembly.* The turbine assembly consists of the turbine wheel with integral shaft, bearing housing, bearings, nozzle assembly, seals, and torus assembly. The torus assembly encloses

the turbine assembly and receives the combustion gases from the combustion chamber and directs these gases to the nozzle vanes. The nozzle assembly forms a shroud around the turbine wheel and contains vanes to direct gases from the combustion chamber against the turbine wheel blades. The turbine wheel is coupled to the compressor shaft by a quill shaft and is supported by two bearings in the bearing housing. The bearings are lubricated from an oil jet in the compressor section. An air-oil seal prevents combustion gases from entering the lubricated areas. An exhaust flange secured to the nozzle assembly conducts exhaust gases from turbine wheel to an exhaust ejector assembly and the muffler assembly. The exhaust flange has mounting provisions for an exhaust gas temperature thermocouple, acceleration and overtemperature control pneumatic thermostat, and oil tank vent fitting.

b. Compressor Section. The compressor is a two-stage centrifugal type utilizing two radial outward flow impellers mounted on a common shaft. An interstaged diffuser (crossover ducts) connects the two compression stages. A second stage diffuser and de-swirl assembly direct the compressed air to the turbine plenum assembly. The compressor assembly is enclosed by a plenum assembly (fig. 4-5), with a screened opening at the top to admit ambient air to the first stage impeller. The plenum assembly also provides mounting provisions for tubular oil cooler, oil tank assembly, low oil pressure switch, oil pressure sequencing switch, and the ignition unit. The compressor shaft is driven through a splined quill shaft connection to the turbine wheel and is connected by another splined quill shaft to the planetary gear train in the accessory section.

c. Accessory Section. The accessory section consists of a planetary reduction drive assembly mounted on the forward end of the compressor section. The accessory drive assembly provides mounting pads and drive gears for six engine accessories; fuel control unit (fig. 4-5), starter motor assembly, oil pump assembly, tachometer generator, centrifugal switch assembly, and cooling air fan assembly. A splined output shaft and ac generator mounting flange is provided for installation of the ac generator. The arrangement of gears in the accessory drive assembly gear train is such that the starter motor assembly drives all accessories in addition to driving the compressor and turbine rotating assemblies during initial starting.

d. Fuel System. The engine fuel system (fig. 4-6) consists of mechanical, pneumatic, and electrical components which function automatically to accelerate the engine to governed rpm with ±100 rpm (turbine wheel rpm) under varying generator set electrical loads. The main components of the engine fuel system are the fuel control unit (fig. 4-5), fuel shutoff solenoid valve, fuel atomizer assembly, and the acceleration and overtemperature control thermostat.

(1) *Fuel control unit.* This unit (fig. 4-6) regulates the flow of fuel to the fuel atomizer assembly in response to engine acceleration conditions and varying load conditions at governed speed. The fuel control unit consists basically of a fuel pump with pressure relief valve and filter, acceleration limiter valve, governor assembly with governor trim control motor, and connections for pneumatic control electrical control, fuel inlet, fuel outlet, fuel bypass, and a seal-leakage drain manifold.

(a) The fuel pump is a two-gear positive displacement, high-pressure pump driven through a splined shaft connected to the accessory gear train. The pump incorporates two steel pump gears with integral shafts. The fuel pump housing contains a spring-loaded, ball-type pressure relief valve which returns fuel (through cored passages in the housing) to the pump inlet after sufficient fuel pressure is attained for operating the engine. A micronic fuel filter element is located adjacent to the fuel outlet port and functions to filter all fuel passing from the fuel pump to the fuel control components.

(b) The acceleration limiter valve is a spring-loaded, diaphragm-controlled relief valve which consists of an adjusting spring, two diaphragm assemblies, a spring-loaded half-ball valve and a cover assembly. The cover assembly incorporates a spring tension adjustment screw and a boss for connection of pneumatic control air. The acceleration limiter valve functions during engine acceleration to control rate of acceleration and exhaust gas temperature in response to pneumatic pressure in the compressor as modulated by the acceleration and overtemperature control thermostat. Fuel flow to the fuel atomizer assembly is constantly regulated by the acceleration limiter valve during engine acceleration to provide the correct fuel flow for the available compressed air and to prevent excessive exhaust gas temperature. When the engine reaches governed speed, the fuel control provided by the acceleration limiter valve is replaced by governor assembly control.

(c) The governor assembly incorporates a governor trim control motor, spring-loaded flyweights, slide-type bypass valve, and an integrator bypass valve. The governor assembly is a centrifugal type governor, driven from the fuel pump shaft, using spring-loaded flyweights to position a slide valve for the bypass of fuel. An increase in centrifugal force on the flyweights, caused by an increase in engine rpm, will reposition

the slide valve to decrease the fuel delivered to the fuel atomizer assembly, thus, reducing engine rpm to the desired governed speed. Conversely, a decrease in centrifugal force (decreased rpm) on the flyweights will increase fuel flow and engine rpm. An integrator bypass valve is connected into the governor system to sense an initial rpm change in the governor and provide a momentary additional change in fuel flow until the governor slide valve again achieves a stable control point after an engine rpm change. This additional bypass valve provides a limiting affect on engine rpm "droop" or "overshoot" from desired governed speed during the time required for the governor to adjust fuel flow for the new condition. The spring tension for the spring-loaded flyweights is controlled by the governor trim control motor through a lever system. The trim control motor, through action on the flyweights, permits frequency output of the generator set to be varied by a frequency adjust rheostat on the electrical controls instrument panel. The position of the rheostat slider is converted by the load anticipator (in the ac electrical system) to an electrical input for the trim motor. As a result of electrical load changes, the load anticipator converts the load change signals to an electrical input to reposition the trim control motor to act on the flyweights and change fuel flow in accordance with the new load requirements without a significant corresponding rpm and frequency change.

(2) *Fuel shutoff solenoid valve.* The fuel shutoff solenoid valve (fig. 4-6) is a normally closed, electrically actuated valve which controls the flow of fuel from the fuel control unit to the fuel atomizer assembly. The valve is energized through the oil pressure sequencing switch when rising oil pressure reaches 2.5 to 3.5 psig (approximately 10 percent governed rpm). The valve is de-energized when the master switch is placed in the OFF position, or if the engine oil pressure should drop below 35 psig, or engine rpm should exceed 110 percent of governed rpm.

(3) *Fuel atomizer assembly.* The atomizer assembly consists of a screen assembly, flow divider valve, dual-orifice type nozzle, and a housing. The housing provides a fuel inlet boss and mounting flanges to secure the atomizer assembly to the combustor cap and combustion chamber assembly. The screen assembly is installed across the fuel inlet to screen all fuel entering the atomizer assembly. The flow divider valve functions to direct fuel flow to the proper orifice plate for the current fuel pressure conditions. During engine start the low pressure fuel is rounted to the low pressure orifice plate to provide proper atomization of the fuel, as fuel pressure increases, the flow divider valve opens (40 ± 1 psig) and bypasses fuel to the high pressure orifice plate, thus providing correct fuel atomization and spray into the combustion chamber assembly under both low and high pressure fuel conditions encountered during engine start and acceleration.

(4) *Acceleration and overtemperature control thermostat.* The acceleration and overtemperature control thermostat is a temperature actuated pneumatic thermostat installed in the turbine exhaust. The thermostat functions to bleed control air from the fuel control unit if engine exhaust gas temperature exceeds safe limits during acceleration and operation. This results in a decrease of fuel from the fuel control unit until temperature is again within safe limits.

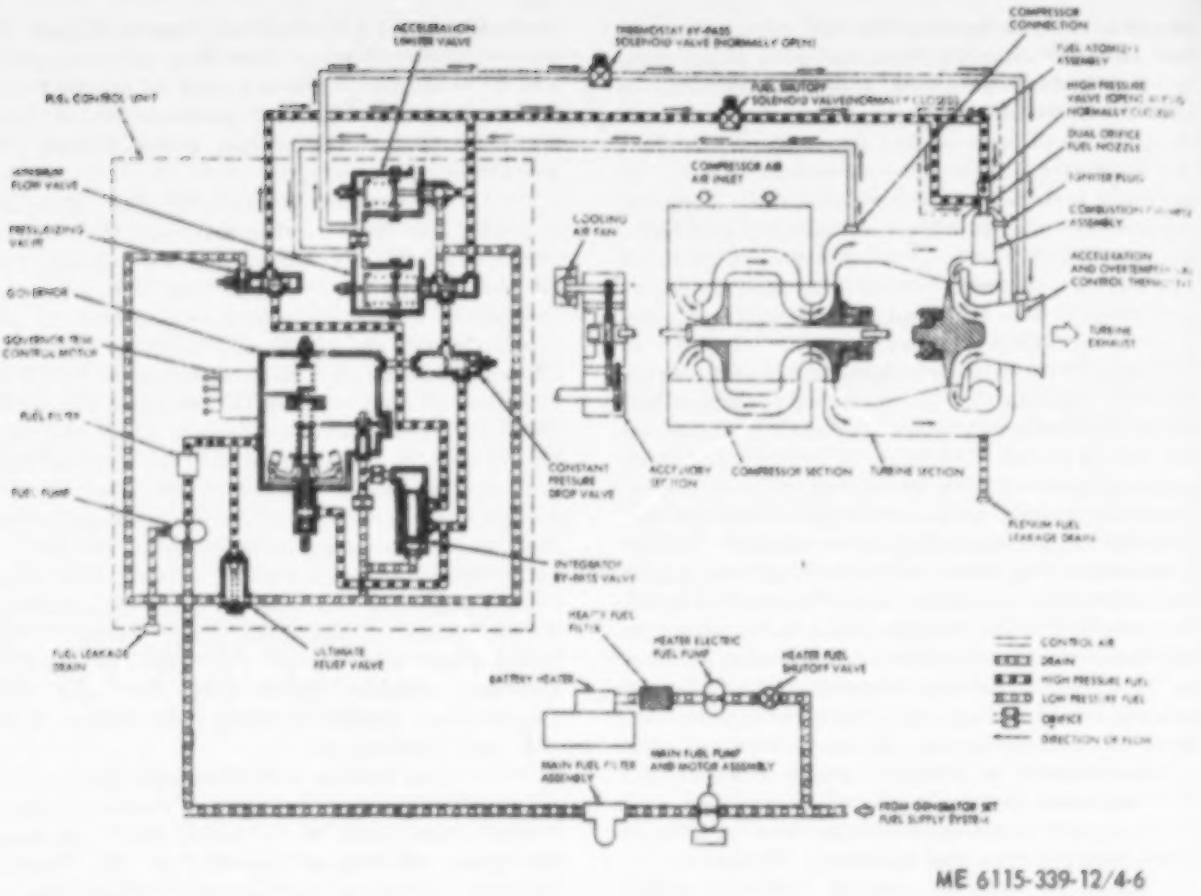

Figure 4-6. Gas turbine engine fuel system schematic.

e. Lubricating System. The lubrication system (fig. 4-7) consists of mechanical, electromechanical, and static components. These components function to store the lubricating oil, provide filtered pressure lubrication to cool and lubricate the planetary gear train and the high speed bearings in the compressor and turbine sections, remove the scavenge oil from the engine sumps, cool the oil, and return the oil to the oil tank assembly, where entrained air is separated and removed from the oil system. In addition, two oil pressure switches use oil pressure for switch actuation to control fuel flow and ignition during engine start and to stop fuel flow if oil pressure drops below 55 psig during engine operation. The lubrication system consists of the oil tank assembly, oil pump assembly, oil filter assembly, oil pressure sequencing switch, low oil pressure switch, tubular oil cooler, and interconnecting piping and fittings.

(1) *Oil tank assembly.* The oil tank assembly (fig. 4-5) provides a 4 quart reservoir for the lubrication system and incorporates a screened oil fill opening with oil fill cap and dipstick assembly, oil drain valve with connections to an external oil drain fitting on the lower left side of the generator set enclosure. An air-oil separator in the tank separates the lubricating oil from entrained air and vents the air to the turbine exhaust flange.

(2) *Oil pump assembly.* The oil pump assembly combines two pumping systems in one housing. The oil pump assembly is driven from the accessory gear train and consists of an oil pressure pump, scavenge pump, and oil pressure relief valve. The two-gear positive displacement oil pressure pump draws lubricating oil from the oil tank assembly and forces the oil to the various engine components requiring lubrication. The pressure relief valve maintains a constant oil pressure to insure adequate and even lubrication of engine parts. The three-gear, positive displacement, scavenge pump draws oil from the various engine oil sumps and forces the oil through the tubular oil cooler and to the oil tank assembly. The oil pump housing provides connection bosses for oil inlets

and outlets and a mounting pad and drive shaft to support and drive the tachometer generator.

(3) *Oil filter assembly.* The oil filter assembly (fig. 4-7) filters all lubricating oil between the pump assembly pressure pump and the engine lubrication points. A 50 to 55 psig bypass valve in the oil filter housing provides a safety bypass for lubricating oil in the event the filter element becomes clogged. The oil filter assembly consists of a filter cover, filter element, and a housing assembly which incorporates the safety bypass valve and oil inlet and outlet fittings.

(4) *Oil pressure sequencing switch.* The switch (fig. 4-5) is installed in the engine lubricating oil line and is actuated by rising oil pressure (2.5 to 3.5 psig) during engine start to energize the fuel shutoff solenoid valve and the ignition unit to initiate combustion. The oil pressure sequencing switch consists of a diaphragm actuating mechanism and a two position electrical switch enclosed in a housing which provides an oil inlet fitting and an electrical connector to mate with the engine wiring harness.

(5) *Low oil pressure switch.* The low oil pressure switch (fig. 4-5) is installed in the engine lubricating oil line and is actuated by rising oil pressure during engine acceleration. When the engine rpm reaches approximately 96 percent governed speed, the electrical circuit through the switch is connected as part of the holding circuit for the fuel shutoff solenoid valve. If, during engine operation, oil pressure drops below 55 psig the switch opens, de-energizing the fuel shutoff solenoid valve and stopping fuel flow to the fuel atomizer assembly. The low oil pressure switch consists of a diaphragm actuating mechanism and a two position electrical switch enclosed in a housing which provides an oil inlet fitting and an electrical connector to mate with the engine harness.

(6) *Tubular oil cooler.* The tubular oil cooler (fig. 4-5) consists of aluminum tubes bonded into a tubular shell assembly and a connecting housing. The connection housing provides inlet and outlet bosses for connection of oil lines. The cooling air fan assembly forces cooling air through the aluminum tubes and discharges the heated exhaust air into the aft section of the generator set enclosure. The scavenge oil pump circulates the hot lubricating oil around the air cooled tubes in the shell assembly, thus removing heat from the oil.

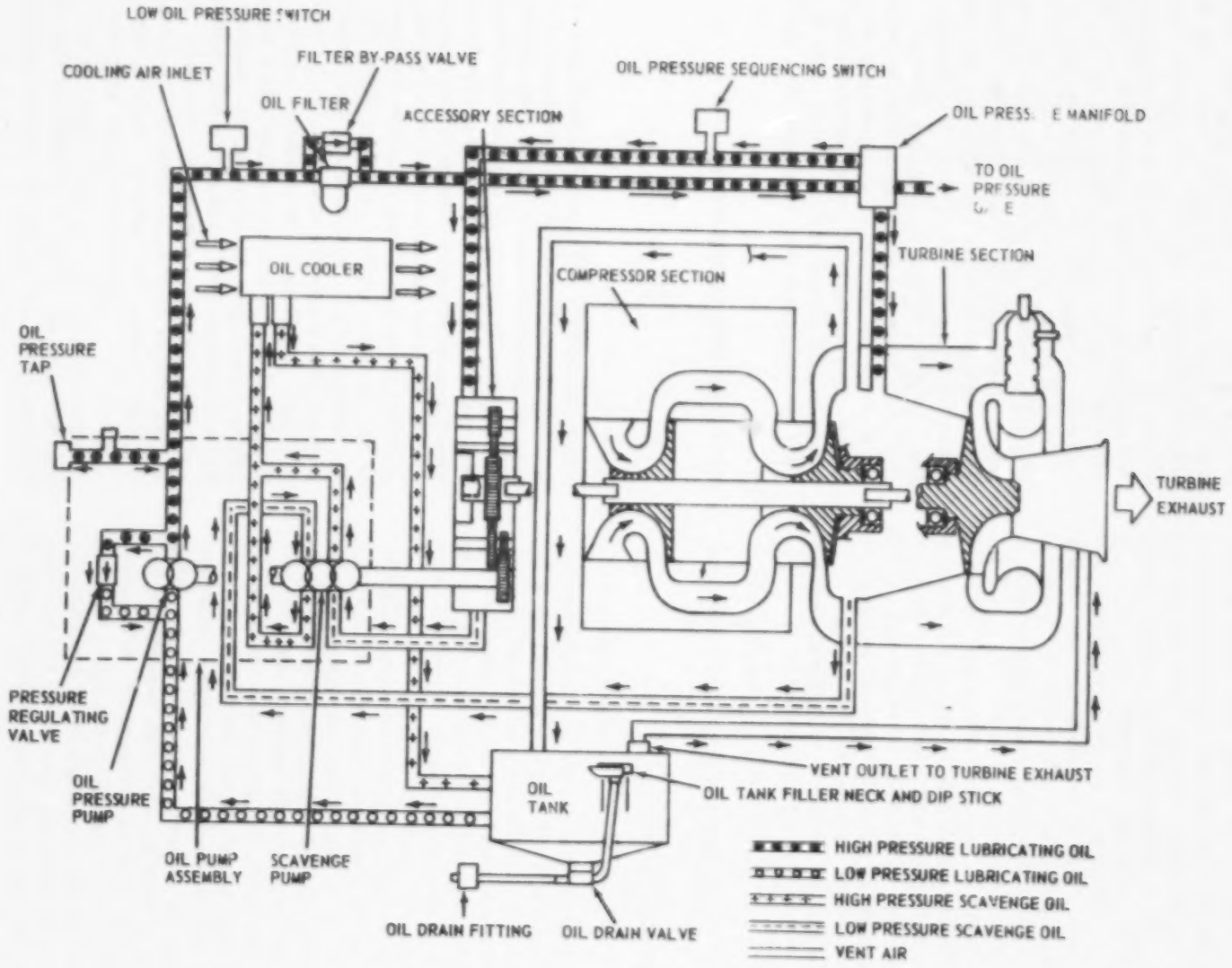

Figure 4-7. Gas turbine engine lubrication system schematic.

f. Electrical System. The gas turbine engine electrical system consists of electrical and electromechanical components which function to start the engine, provide automatic starter and ignition cutout, connect the ac generator exciter circuit at approximately 95 percent governed speed, and provide overspeed protection for the engine. The main components of the engine electrical system are the start relay, starter assembly, centrifugal switch assembly, ignition unit, igniter plug, tachometer-generator, and holding relays K3 and K4.

(1) *Start relay.* The start relay (K1, FO-1) is a solenoid actuated relay which functions to connect the starter motor to the 24 v dc system. The relay is actuated through the master switch (S-2) START position and de-energized by actuation of the starter cutout switch in the centrifugal switch assembly.

(2) *Starter assembly.* The starter assembly consist of a dc starter motor (B-1) with a pawl and clutch mechanism mounted on the motor shaft to engage a ratchet in the accessory assembly train. The three pawls are in a spring-loaded retracted position until the starter motor is energized. When the starter shaft rotates, the inertia of the pawls overcomes the spring load and forces the pawl teeth inward to engage the ratchet. The engagement shock is absorbed by the clutch mechanism which slips until gear train rotation has accelerated to starter rotation speed. The starter motor operates until the engine combustion occurs and engine speed reaches approximately 35 percent governed speed, at which time the starter circuit is de-energized through actuation of the starter cutout switch in the centrifugal switch assembly. The engine control circuits prevent the starter from being accidentally re-engaged when the engine is at operating speed.

(3) *Centrifugal switch assembly.* This assembly consists of spring-loaded flyweights driven from the accessory gear train, a spring-loaded actuating lever, three switch assemblies, three adjustment screws with springs and push rods, and an electrical receptacle wired to the three switches. The three switches actuate in a calibrated sequence in response to engine rpm to control various component functions. The first switch in the sequence actuates at approximately 35 percent of governed speed and de-energizes the starter motor circuit. The second switch actuates at approximately 95 percent governed speed and de-energizes the ignition unit and closes the generator control relay to apply field current to the ac generator. The third switch is an engine overspeed shutdown switch and only actuates if the engine rpm should reach 110 percent governed speed. The Overspeed protection switch will disconnect any electrical load on the generator set and de-energize the fuel shutoff solenoid valve to stop fuel flow to the atomizer assembly and shutdown the engine.

(4) *Ignition unit.* The ignition unit (fig. 4-5) is a capacitor discharge type that provides high output voltage to the igniter plug. The ignition unit is energized through the oil pressure sequencing switch when engine oil pressure reaches approximately 3 psig. The unit is de-energized through the centrifugal switch assembly when engine speed reaches approximately 95 percent governed speed.

(5) *Igniter plug.* The igniter plug (fig. 4-5) produces an intermittent high voltage spark to initiate combustion of the fuel air mixture in the combustion chamber. The plug is connected to the ignition unit. The discharge end of the plug protrudes through the wall of the combustion chamber into the combustion area.

(6) *Tachometer-generator.* The tachometer-generator (fig. 4-5) is a two-pole, three phase ac generator that is mounted on the oil pump assembly and driven from the accessory drive section. The tachometer-generator provides an ac output signal which is proportional to engine speed. The signal energizes the tachometer indicator on the engine control instrument panel.

(7) *Holding relays (K3 and K4).* These relays (FO-1) are of the four-pole, double-throw type and are energized in sequence. Each of the relays, when initially energized, completes a circuit through contacts to its holding coil and remains energized until the holding circuit is de-energized. K3 is initially energized by actuation of the MASTER switch to START position. This completes the relay holdin circuit to bypass the START position of the MASTER switch and completes the power circuits to the two oil pressure switches and the centrifugal switch assembly. K3 is de-energized when the MASTER switch is placed in the OFF position or in the event the turbine reaches an overspeed condition and the overspeed shutdown switch in the centrifugal switch assembly opens. K4 is energized when the ready to load switch (96 percent switch) in the centrifugal switch assembly closes. Actuation of K4 completes the relay holding circuit, completes a hold-in circuit to the fuel shutoff solenoid valve, and disconnects the ignition circuit. K4 is de-energized when K3 is de-energized. Deactivation of K3 results in de-energizing all holding circuits and shutdown of the engine.

4-12. Fuel Supply System

The fuel supply system (fig. 4-8) provides fuel storage and control of fuel delivery to the gas turbine engine and winterization installation. See

figures 4-9 and 4-10. The fuel supply system plumbing installation provides for operation of the generator set from an external source without going through the fuel tank assembly, operation from the integral fuel tank with supply automatically replenished from an external source, operation from the integral fuel tank alone, and operation from another generator set fuel tank serving as an external supply. A screened filler neck is provided for manual filling of the fuel tank as well as automatic filling by the auxiliary fuel pump. A fuel level gage provides visual indication of fuel supply in the integral tank. A 25 foot external fuel supply hose provides for connection to an external fuel supply. The fuel supply system consists of a skid mounted enclosed fuel tank assembly, main fuel pump, fuel filter assembly, heater fuel shutoff valve, heater fuel pump, heater fuel filter, and interconnecting hoses, tubing, and fittings.

a. Skid Mounted Enclosed Fuel Tank Assembly. The fuel tank assembly provides fuel storage, fuel level control, and fuel supply selection control in a compact self-contained unit which is separable from the generator set. A skid base assembly secured to the bottom of the tank assembly enclosure provides protection for the tank and support for the tank and generator set. Fuel level in the tank is automatically controlled by a float system electrically connected to an auxiliary fuel pump (fig. 4-9). An auxiliary tank, float switch, and warning light protect the auxiliary pump when external fuel is depleted. A bypass switch provides for operation of the auxiliary pump to reprime the system after connection of an external fuel supply. A low, low fuel level float switch provides for shutdown of the engine to protect the fuel system from loss of prime and possible damage to engine fuel pump from operation without fuel for lubrication in the event the fuel supply is depleted. The fuel tank assembly consists basically of a fuel storage tank (fig. 4-8), auxiliary fuel pump, fuel filter assembly, auxiliary tank assembly, high level float switch, low level float switch, low low level float switch, fuel level gage, low fuel indicator lamp, controlled rectifier circuit, three-way selector valve, float switch bypass switch, a fuel tank drain valve, and fuel tank enclosure.

(1) *Fuel storage tank.* The tank (fig. 4-8) is a rectangular welded aluminum tank with a capacity of 65 gallons. The tank is enclosed and supported by the enclosure assembly. A non-siphoning, flame arresting vent system provides venting of the tank in any position. On generator sets bearing Part No. 13207E3830-3, the vent system is identical except remote venting is provided through fittings located on the front of the enclosure. The bottom of the tank is constructed to slope to a common sump to permit draining. A filler neck with cap and captive screen assembly are provided for manual filling of the tank.

(2) *Auxiliary fuel pump.* The auxiliary fuel pump (fig. 4-8) is a rotary gear-type pump driven by a 24v dc electric motor. Output pressure is maintained at 15 +3/--0 psig by an adjustable pressure relief valve. The pump is capable of delivering rated output when the fuel source is located up to a maximum of 25 feet from, and 12 feet below, the pump inlet. Operation of the pump is automatically controlled by the auxiliary tank float switch, high level float switch, and the low level float switch. A manual bypass switch provides for operation of the pump regardless of the position of the auxiliary tank float switch and low level float switch. The pump cannot be operated if the fuel storage tank is full.

(3) *Fuel tank fuel filter assembly.* This assembly (fig. 4-8) is a line-type micronic filter with a capacity of 12 gallons per minute. The filter assembly is mounted on the fuel tank enclosure and filters all fuel discharged from the auxiliary tank. The filter assembly consists of caps which encloses the filter element, a replaceable filter element, and a housing which provides inlet and outlet fittings and mounting holes.

(4) *Auxiliary tank assembly.* The assembly provides auxiliary fuel pump protection by shutting off the pump in the event the external fuel supply is depleted. A float switch in the tank opens the electrical circuit to the pump motor when the auxiliary tank is empty and closes the circuit to the low fuel warning light. A push button switch (pump prime switch) provides a bypass circuit around the float switch to operate the pump during priming until the auxiliary tank is filled. A manually operated bleed air valve installed in the top of the auxiliary tank provides air bleed until the tank is filled with fuel.

(5) *High level float switch.* This switch is installed in the upper portion of the fuel storage tank and actuates to shutdown the auxiliary fuel pump when the fuel storage tank is full. When the fuel level drops below full the switch will reactivate the auxiliary boost pump.

(6) *Low level float switch.* The switch is installed in the lower portion of the fuel storage tank and actuates with rising fuel level to open a bypass circuit around the auxiliary fuel pump.

(7) *Low low level float switch.* This switch is installed in the lowest portion of the fuel storage tank and actuates with decreasing fuel level to open a holding circuit to the engine.

(8) *Fuel level gage.* The gage is a float actuated dial pointer gage calibrated to indicate fuel depth in the fuel storage tank. It is located in the side of the fuel storage tank.

(9) *Low fuel indicator lamp.* The lamp is located in front of the fuel tank assembly. It is energized when the auxiliary tank float switch is in the low position and indicates that the external fuel supply is depleted.

(10) *Controlled rectifier circuit.* The controlled rectifier circuit (fig. 4-10) is installed across the auxiliary fuel pump electrical circuit and provides an electrical gate to control pump operation in response to actuation of the auxiliary tank float switch, float switch bypass switch, and low level float switch. Actuation of the SCR (silicon controlled rectifier) is initiated by the application of a bias voltage through the gate resistor to the rectifier. The SCR will remain open to permit current flow to the pump motor as long as the bias voltage is applied through the gate resistor. If the bias voltage is stopped, the SCR blocks the flow of current to the pump motor.

(11) *Three-way selector valve.* This valve (fig. 4-8) is a three-position, manually actuated valve installed across the fuel inlet and outlets of the fuel supply system to control fuel source selection.

(12) *Float switch bypass switch.* When activated the switch bypasses the auxiliary tank float switch to apply bias voltage to the SCR and current to the pump motor. See figure 4-10. The switch is used during priming of the auxiliary tank assembly and is required only until the auxiliary tank float switch is actuated by rising fuel.

b. Main Fuel Pump. The main fuel pump is a rotary gear-type pump driven by a 24v dc electric motor. Output pressure is maintained at 15 + 3 /−0 psig by an adjustable pressure relief valve. The main fuel pump delivers fuel to the gas turbine engine at a constant pressure from an external source or from the fuel tank. Operation of the pump is initiated when the master switch is placed in the RUN position and continues until the switch is placed in the OFF position.

c. Main Fuel Filter Assembly. The assembly is a line-type micronic filter with a capacity of 50 gallons per minute at a maximum pressure of 15 psig. The replaceable filter element will retain 99.5 percent of all particles larger than 10 microns. The filter assembly is installed in the fuel line between the main fuel pump and the engine fuel control unit.

d. Heater Fuel Shutoff Valve. The valve is a two-position, manually activated valve installed across the fuel line to the battery heater. The valve provides on-off control of fuel flow to the battery heater.

e. Heater Fuel Pump. The pump is an electrically actuated, solenoid-operated reciprocating pump with an internal bypass valve to maintain a constant output pressure. The pump draws fuel from the fuel tank or an external fuel source and delivers it to the battery heater through the battery heater fuel filter.

f. Heater Fuel Filter. The filter is a line-type filter installed across the fuel inlet to the battery heater. The housing provides threaded inlet and outlet bosses and mounting holes.

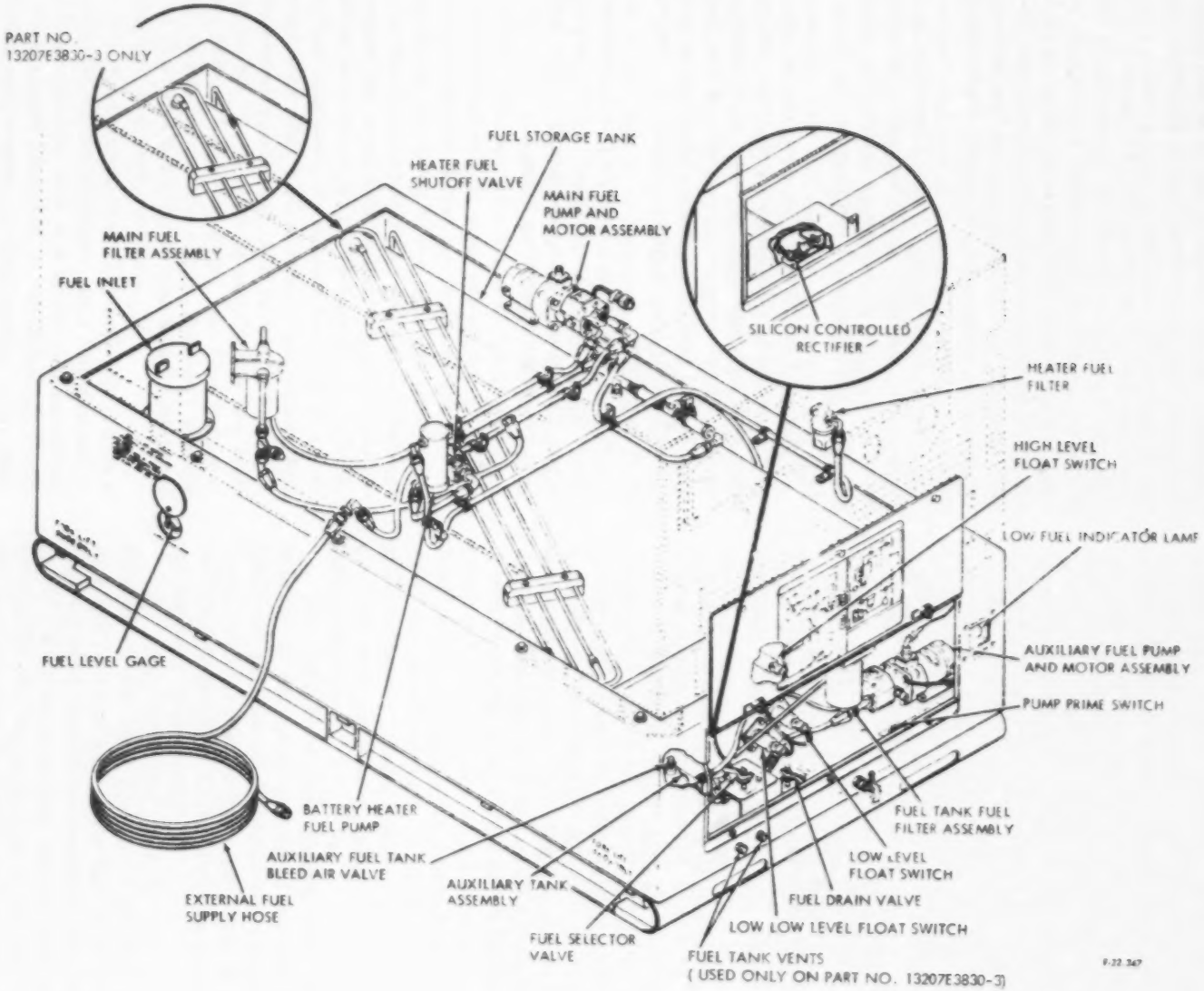

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Figure 4-8. Fuel supply system.

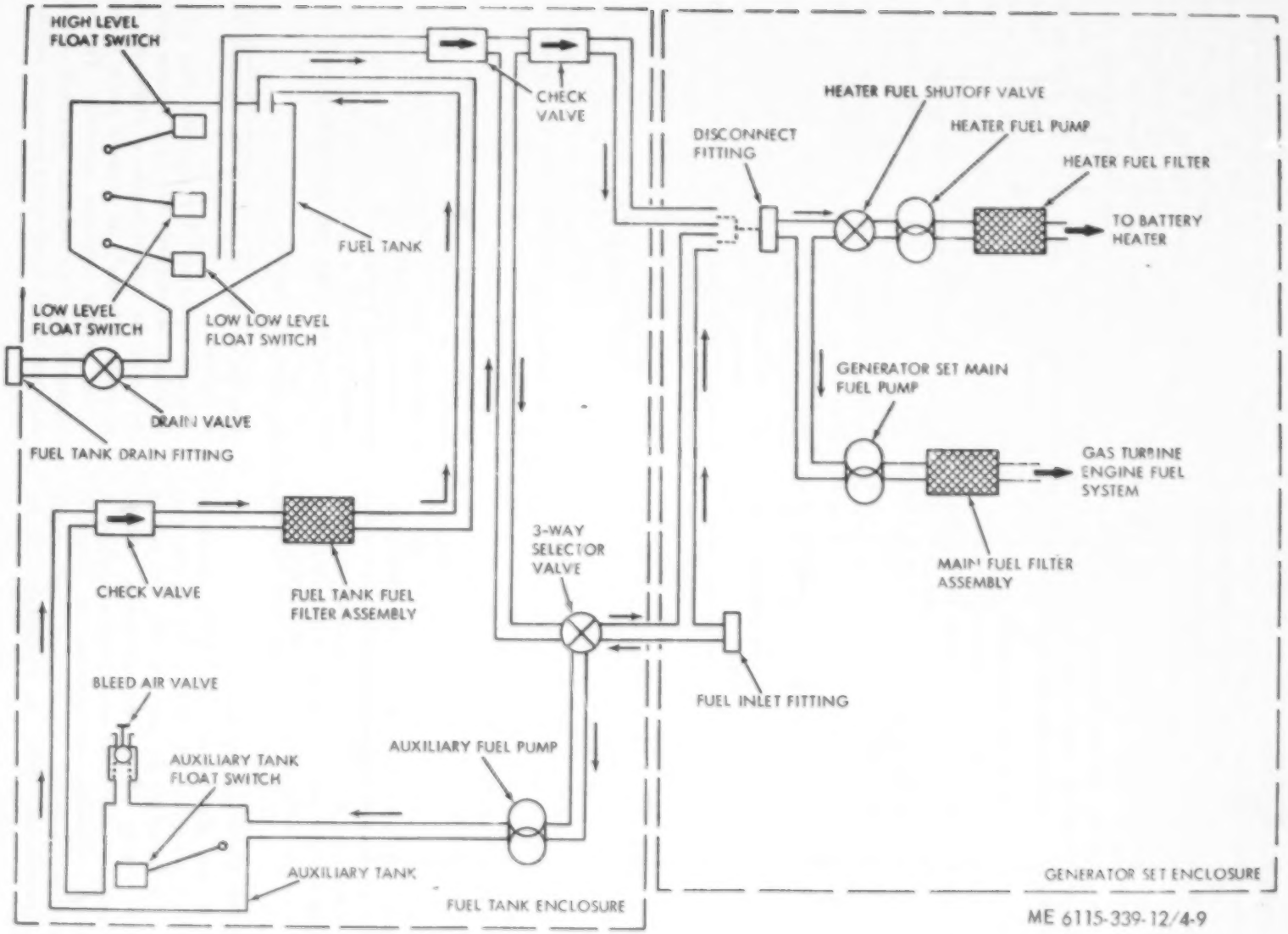


Figure 4-9. Fuel supply system fuel flow schematic.

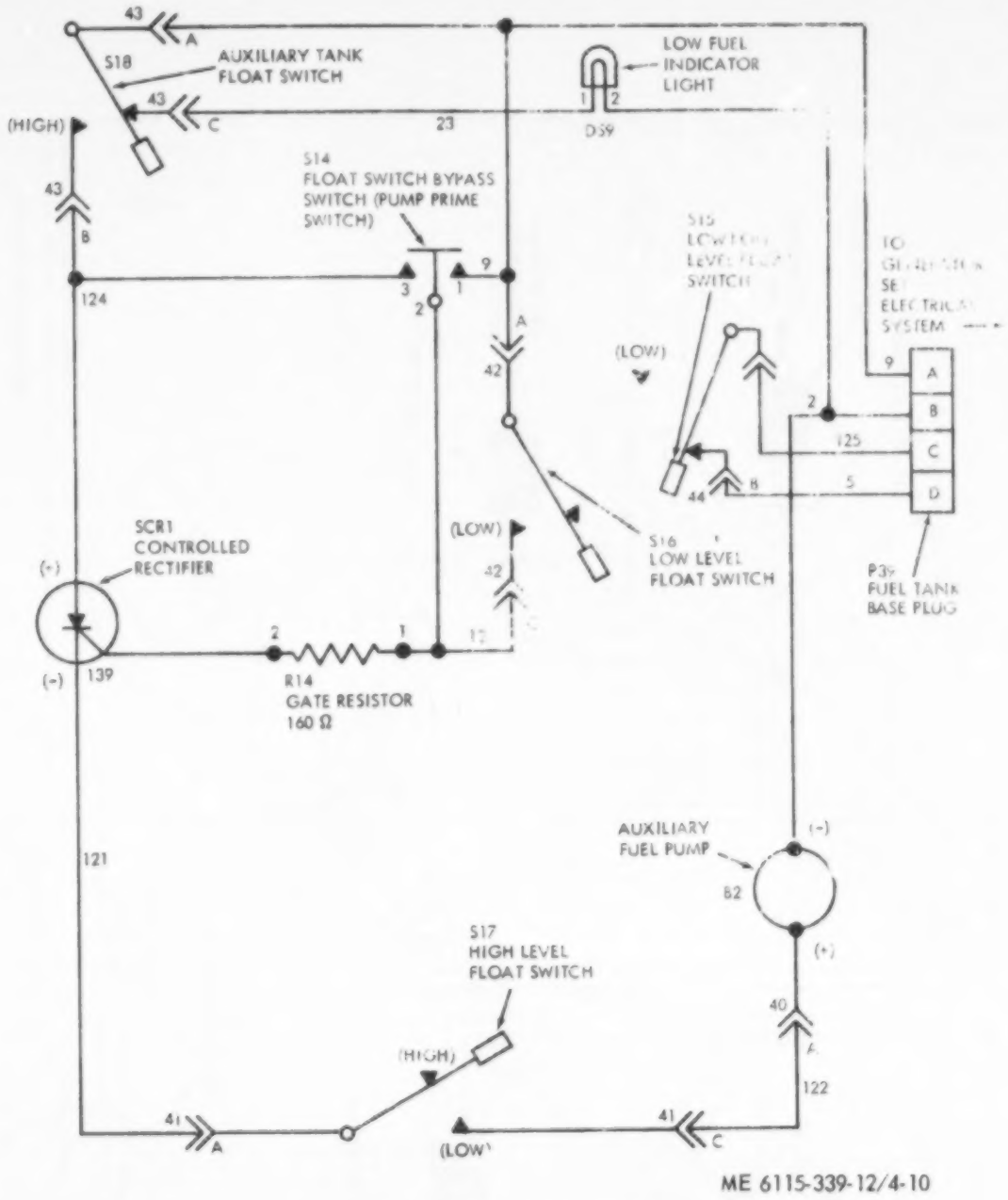


Figure 4-10. Fuel supply system, electrical schematic.

4-13. AC Electrical System

The ac electrical system (fig. 4-11) generates, regulates, controls, and protects the ac electrical output produced by the generator set. The system consists mainly of the ac generator, voltage regulator assembly, load anticipator assembly, ac generator protection components, ac electrical connection panels and outlets and various controls and instruments. Refer to paragraph 2-7 for description and purpose of the controls and instruments.

a. AC Generator. The generator (fig. 4-11) is a brushless, self-excited, 400 hps, 3-phase generator driven by the turbine engine at 6000 rpm. As the generator is brought up to speed power is supplied to the voltage regulator assembly. The voltage regulator assembly supplies regulated current (as required by the load) to the generator exciter field

windings. As the exciter armature conductors cut the magnetic field of the exciter field windings, a voltage is induced in the armature. The ac output of the exciter armature is then fed to the rectifier assembly which converts it to dc current to feed the rotor windings of the generator. As the rotor rotates, the stator windings cut the magnetic field of the rotor and a voltage is built up. The generator stator is wound for dual voltage of 120 / 208 and 240 / 416 to permit voltage reconnection at the voltage change panel assembly (fig. 1-2). The generator is cooled by an internal fan which draws blast air from the cooling air fan in the engine accessory section (fig. 4-5). The generator is automatically brought up to voltage when the engine reaches approximately 95 percent governed speed by the closing of the generator control relay to supply the generator exciter field current through the voltage regulator.

b. Voltage Regulator Assembly. The voltage regulator maintains a constant generator output voltage by varying the exciter field current to the generator exciter assembly. An increase in load results in a voltage drop across the control components of the voltage regulator assembly. This voltage drop will result in increased current to the generator exciter field and, consequently, increased generator output to return the voltage to the desired output. A decrease in load will have the opposite effect.

c. Governor-Load Anticipation Control. The control function in conjunction with the governor trim control motor on the fuel control unit to sense a load change and to produce an appropriate signal to the governor trim control motor to position the governor control spring to change fuel flow immediately upon change in load. This prevents engine rpm droop and overshoot to minimize generator frequency transients. Load sensing is through watt sensing circuits. The load anticipator can be adjusted by the frequency adjusting rheostat, the frequency droop adjusting rheostat, and the load anticipation gain adjust rheostat. See figure 4-11.

NOTE

The load anticipation gain adjust rheostat is factory adjusted and should not be disturbed in the field.

d. AC Generator Protection Components. The generator protection components protect the generator and loads from damage caused by overvoltage, undervoltage, and short circuit conditions external to the generator set. When any of these conditions occur, the appropriate control relay actuates to open the main circuit breaker to disconnect the electrical load. In addition, if an overvoltage condition occurs, control relays are energized to remove exciter excitation, causing the generator output voltage to drop to approximately zero.

e. AC Electrical Connection Panels and Outlets. The electrical panel and outlets provide connection points for various power requirements and connectors for external electrical loads. The connection panels and outlets are listed below.

(1) *Voltage distribution panel.* This panel (fig. 4-11) consists of a terminal block with generator windings connected to the terminals and a voltage change panel assembly which connects the terminals to deliver 120 / 208 volts in one position and 240 / 416 volts in the other.

(2) *AC power panel.* The power panel accomodates separate electrical leads with terminals and will carry the full output of the generator set for both possible connectons of the generator windings. The ac power panel provides a terminal block with four terminals for the three phase connections and neutral (L1, L2, L3, and L0).

(3) *400 Hertz power receptacle J18.* Receptacle J18 accomodates electrical leads which terminate in a mating connection plug. The receptacle will carry the full output of the generator set for both possible voltage connections of the generator windings.

(4) *120-Volt-400 Hertz convenience receptacle.* The convenience receptacle provides two standard 120-Volt receptacles for connection of drop cord lights, portable tools, and other non-scheduled 120 volts, single phase 400 hps electrical loads that do not exceed 15 amps total.

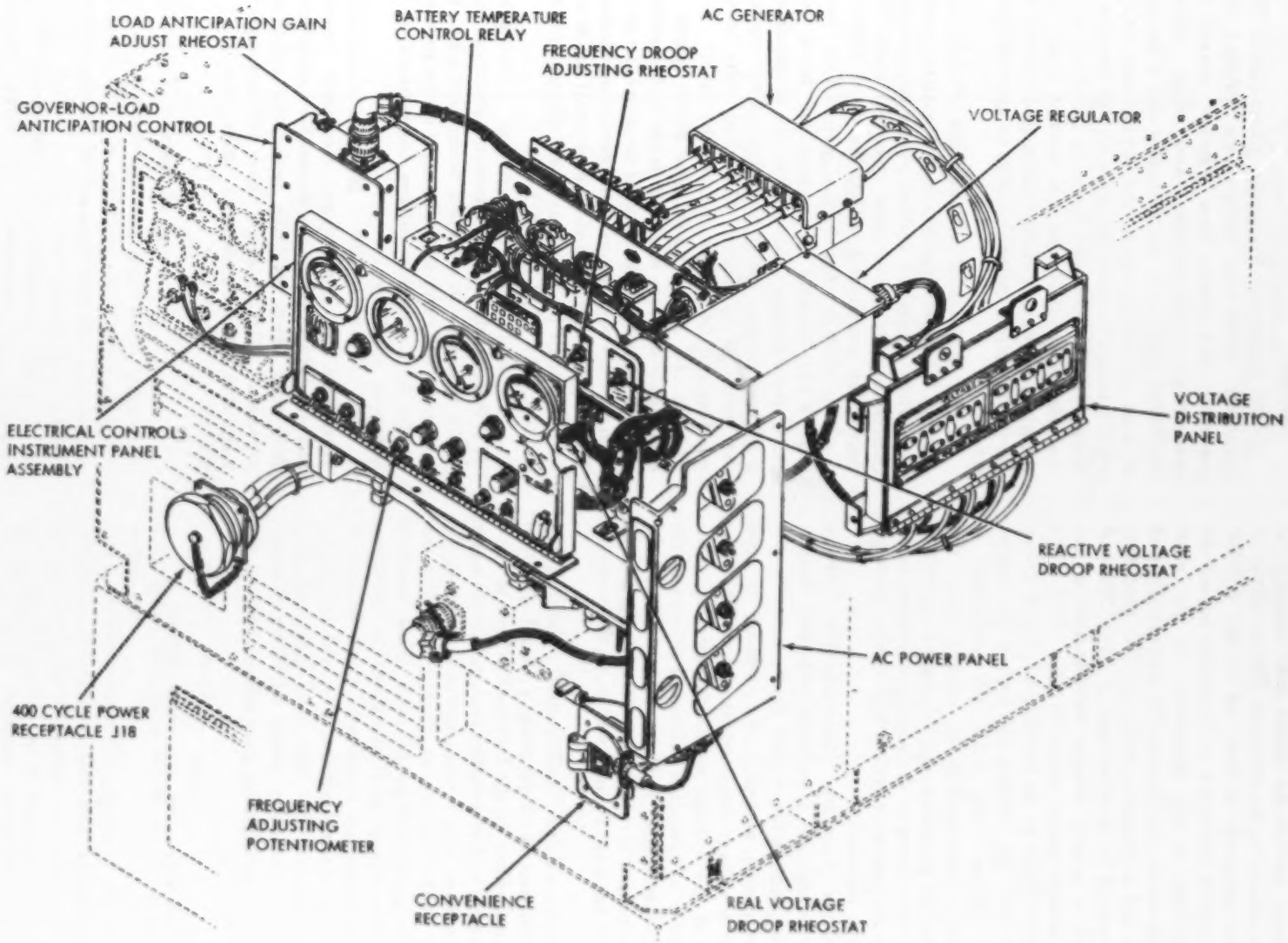


Figure 4-11. AC electrical system.

4-14. DC Electrical System

The dc electrical system provides 24-volt dc electrical power for engine starting and operation and for winterization equipment operation. Basically the dc electrical system consists of the battery, battery charger, 24V dc slave receptacle J15, and the various dc controls and instruments.

a. Battery. The battery installation consists of two 12 volt lead-acid type storage batteries, connected in series to deliver 24 volts, and installed in a plastic battery box assembly. The batteries are recharged during engine operation by the battery charger (fig. 4-12) and may also be recharged when the engine is not operating by applying charging current through the 24 volt slave receptacle J15. A battery electrolyte temperature sensor is installed in one cell of one battery to provide automatic control of the winterization installation when energized.

b. Battery Charger. The battery charger is a transformer-rectifier unit which transforms and rectifies ac power from the generator and delivers a regulated and adjustable 24v dc, 15 amp output for recharging the batteries and operating 24v dc components of the engine and fuel supply electrical system.

c. Slave Receptacle J15. An external source of 24v dc can be connected to J15 to start the engine, charge the batteries, or for operation of the winterization equipment.

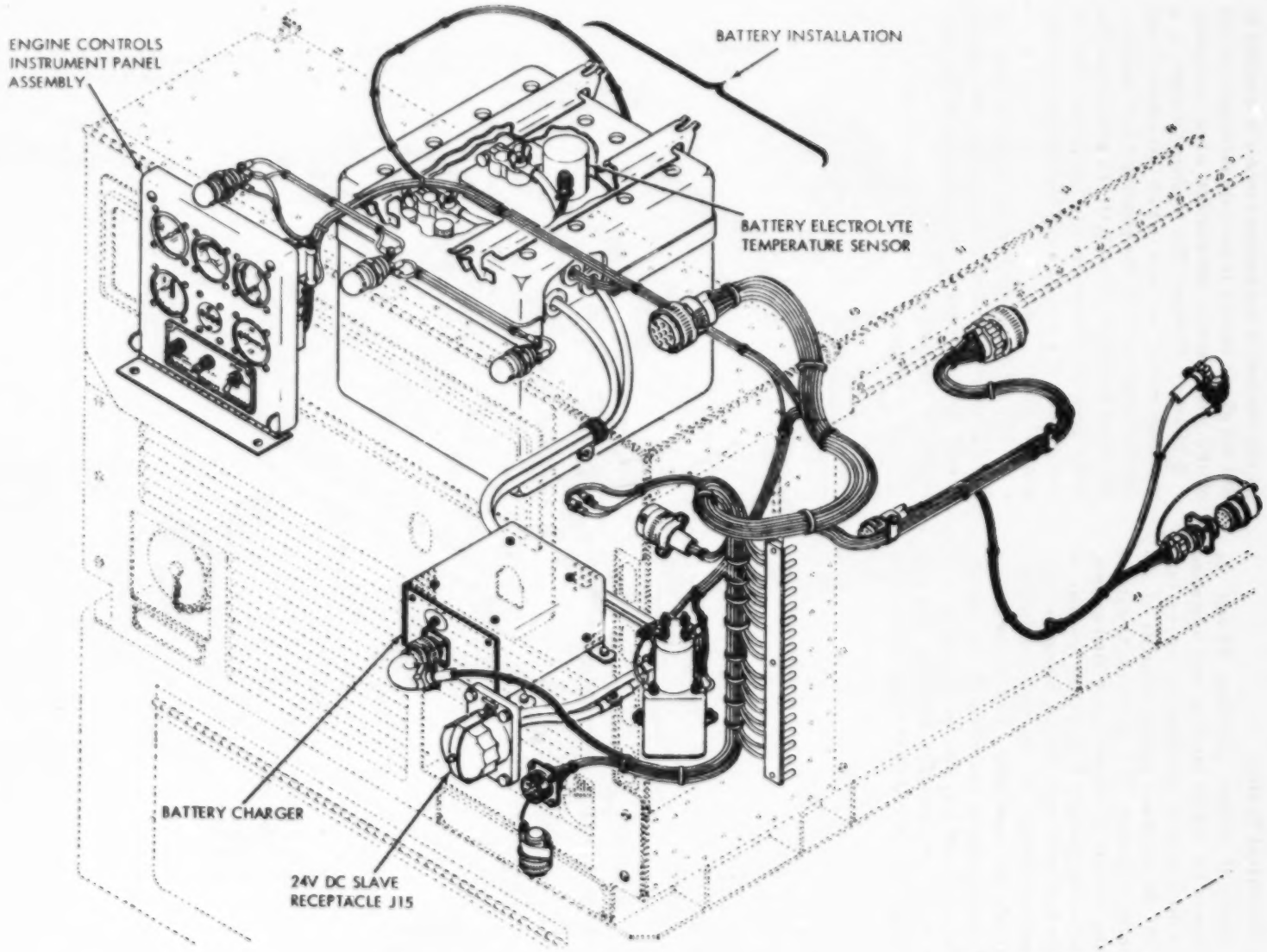


Figure 4-12. 24V Electrical system.

4-15. Controls and Instruments

Refer to paragraph 2-7 for a complete description and purpose of the controls and instruments used to control this equipment.

4-16. Winterization Installation.

The winterization equipment (fig. 4-13) automatically provides heated air to the battery box assembly if the winterization heater switch (fig. 2-4) is in the ON position and battery electrolyte temperature is 0° F. or below. Heater operation is stopped by the electrolyte temperature sensor where the electrolyte temperature reaches 20° F. The winterization equipment consists of the internal combustion battery heater electrolyte temperature sensor, battery temperature control relay, hot air and exhaust ducts, and winterization equipment controls and instruments.

a. Internal Combustion Battery Heater. The heater (fig. 4-13) provides heated air to the battery box assembly to prevent the electrolyte from freezing during cold weather conditions. Fresh air is drawn around a combustion chamber within the heater by an electrically driven fan and ducted to the bottom of the battery box through the hot air duct. Operation of the heater is controlled by the electrolyte temperature sensor through battery temperature control relay. Heater fuel is obtained from the generator set fuel supply system through heater fuel filter assembly heater electric pump, and the heater fuel shutoff valve. Initial ignition of heater fuel is accomplished by an igniter plug which is de-energized after combustion by a flame switch in the heater combustion chamber. Combustion chamber exhaust is ducted outside by the generator set exhaust ducts.

b. Battery Electrolyte Temperature Sensor. The sensor is a transistorized, thermistor controlled, temperature sensing device used to automatically control the operation of the heater during extreme cold weather conditions. The thermistor probe extends into the battery electrolyte to monitor the temperature. The sensor energizes the temperature control relay to energize the battery heater when the electrolyte temperature decreases to 0° F. The heater is de-energized when the electrolyte temperature increases to 20° F.

c. Battery Temperature Control Relay. The temperature control relay (K9) (fig. 4-11) is located on the electrical rack assembly behind the electrical controls instrument panel. The relay functions to complete the control circuit to the battery heater when actuated by the electrolyte temperature sensor. When the electrolyte temperature reaches 20° F., the relay is de-energized by the opening of the electrolyte temperature sensor and opens the electrical circuit to the battery heater.

d. Hot Air Duct. The hot air duct (fig. 4-13) is a formed and welded sheet metal duct installed between the battery heater hot air discharge and the bottom of the battery box. The air is routed from the battery heater to battery box.

e. Exhaust Duct. The exhaust duct is installed between the battery heater exhaust outlet and the exterior of the generator set. The duct provides alternate outlets to the exterior of the generator set for the battery heater exhaust products: one outlet to the bottom of the generator set and one to the left side. The exhaust outlet to the bottom is not usable when the fuel tank is installed.

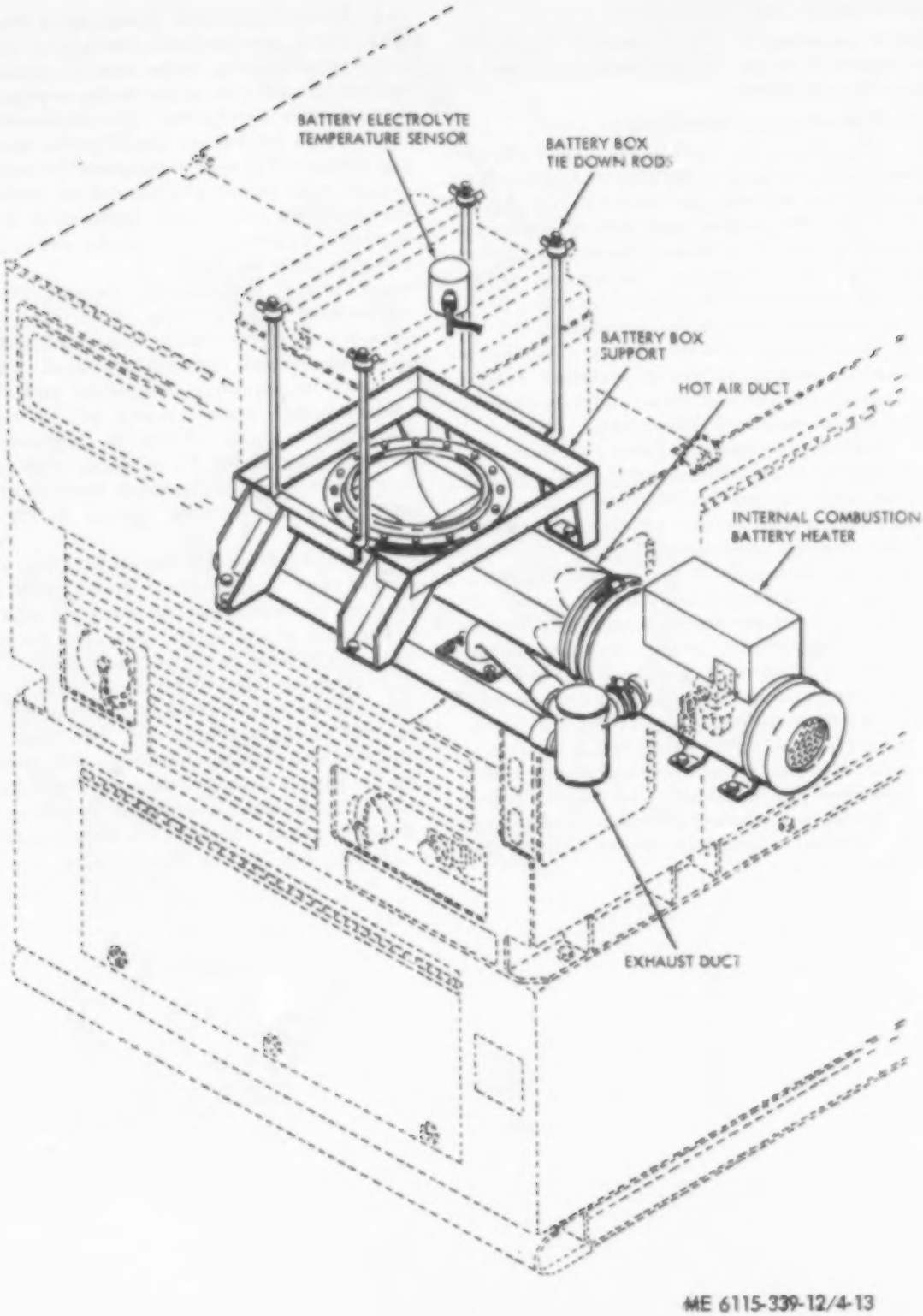


Figure 4-13. Winterization installation.

4-17. Enclosure Assembly

The enclosure assembly (fig. 4-14) is a lightweight, weather resistant, sound absorbing assembly providing structural support and protection for the generator set components. The assembly consists basically of the muffler assembly, doors, access panels, end cover, and the frame assembly.

a. Muffler Assembly. The muffler assembly (fig. 4-14) provides a sound attenuated receiver for engine exhaust. A screened opening across the top of the muffler provides for release of exhaust gases. A drain fitting in the bottom provides for draining of moisture trapped in the muffler.

b. Door Assemblies. The door assemblies are hinged to the enclosure frame and are provided with one-quarter turn quick-disconnect fasteners.

c. Access Panel Assemblies. The access panel assemblies consists of the top center panel, aft top panel, flame tube removal access panel, and the lower front panel.

d. Enclosure Forward End Cover. This cover is a canvas protective cover installed when transporting or storing the generator set. The cover is provided with snap fasteners to mate with fasteners on the front of the generator set.

e. Enclosure Frame Assembly. This assembly is a welded and riveted structure which provides support and mounting provisions for the generator set components.

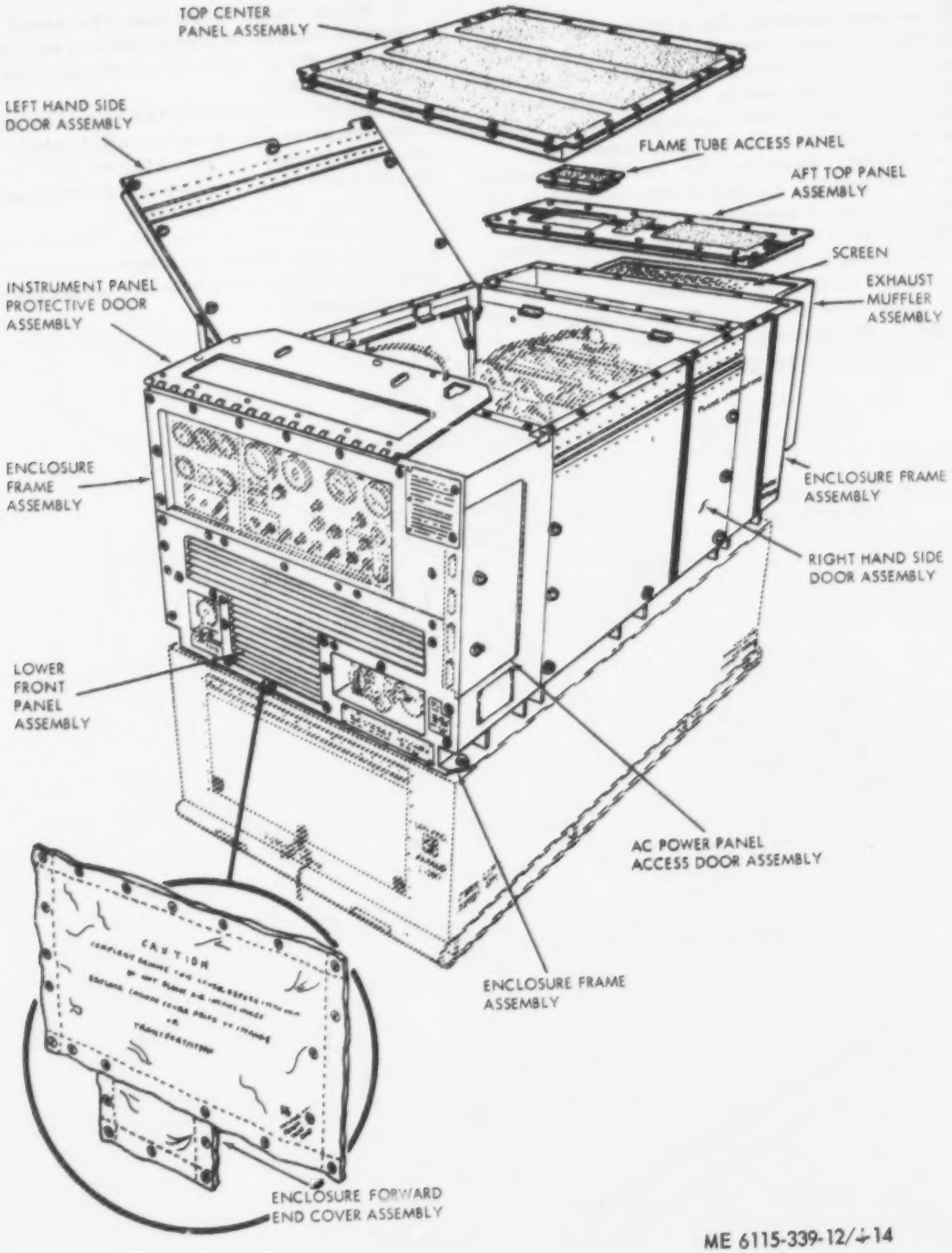


Figure 4-11. Enclosure assembly.

Section VII. FUEL SYSTEM

4-18. General

The generator set draws fuel from either an external supply or the fuel tank. Float valves in the fuel tank automatically start the auxiliary fuel pump and motor assembly to refill the fuel tank and shut off the pump when the fuel tank is full. The main fuel pump (identical to the auxiliary fuel pump) draws fuel from the fuel supply and delivers fuel to fuel control unit. The fuel control unit provides controlled fuel flow through the fuel solenoid valve to the fuel atomizer assembly.

CAUTION

Be sure fuel lines do not make physical contact with other surfaces of the generator set. The high frequency vibration during operation may cause rapid wear and damage of the fuel lines leading to fuel system failure.

4-19. Fuel System Service

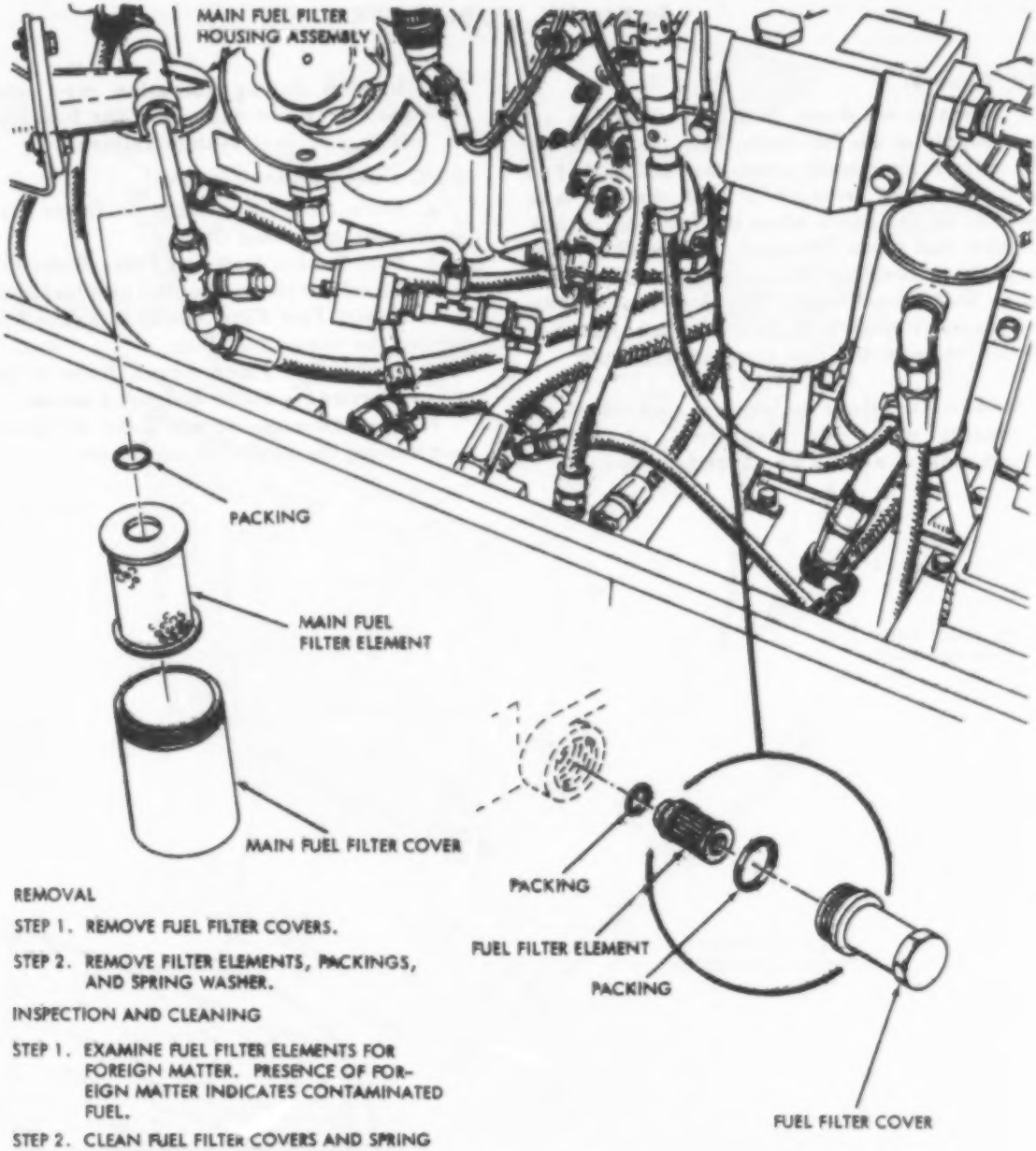
a. Main Fuel Filter. Refer to figure 4-15 and service the main fuel filter.

b. Fuel Control Unit fuel Filter. Refer to figure 4-15 and service the fuel control unit fuel filter.

c. Heater Fuel Filter. Refer to figure 4-16 and service the heater fuel filter.

d. Heater Fuel Pump Screen. Refer to figure 4-17 and service the heater fuel pump screen.

e. Fuel Atomizer Screen. Refer to figure 4-18 and service the fuel atomizer screen.



REMOVAL

STEP 1. REMOVE FUEL FILTER COVERS.

STEP 2. REMOVE FILTER ELEMENTS, PACKINGS, AND SPRING WASHER.

INSPECTION AND CLEANING

STEP 1. EXAMINE FUEL FILTER ELEMENTS FOR FOREIGN MATTER. PRESENCE OF FOREIGN MATTER INDICATES CONTAMINATED FUEL.

STEP 2. CLEAN FUEL FILTER COVERS AND SPRING WASHER IN AN APPROVED CLEANING SOLVENT AND DRY THOROUGHLY.

INSTALLATION

STEP 1. INSTALL NEW FILTER ELEMENTS AND NEW PACKINGS IN REVERSE ORDER OF REMOVAL PROCEDURE.

STEP 2. OPERATE ENGINE FOR 5 MINUTES AND CHECK FUEL FILTERS FOR LEAKAGE.

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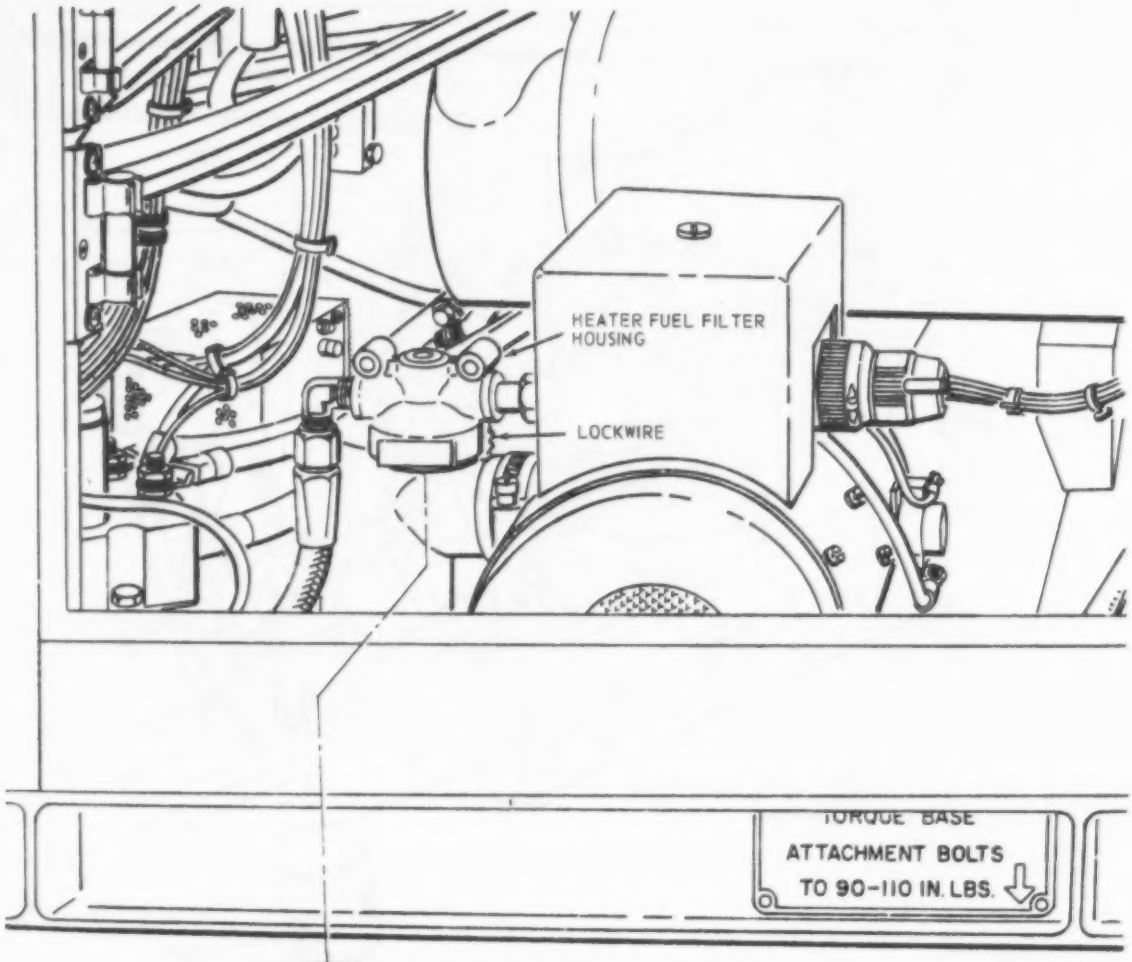
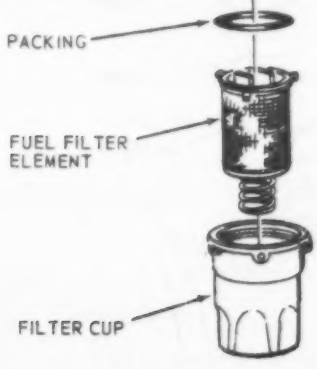
Figure 4-15. Main fuel filter and fuel control unit filter service.





REMOVAL
STEP 1. REMOVE LOCKWIRE, FILTER CUP, AND PACKING FROM HEATER FUEL FILTER HOUSING.
STEP 2. REMOVE AND CLEAN FUEL FILTER ELEMENT.

CLEANING
STEP 1. CLEAN FILTER CUP WITH AN APPROVED CLEANING SOLVENT AND DRY THOROUGHLY.

INSTALLATION
STEP 1. INSTALL FUEL FILTER ELEMENT, NEW PACKING, FILTER CUP, AND LOCKWIRE IN REVERSE ORDER OF REMOVAL PROCEDURE.
STEP 2. OPERATE HEATER AND CHECK FOR LEAKS.

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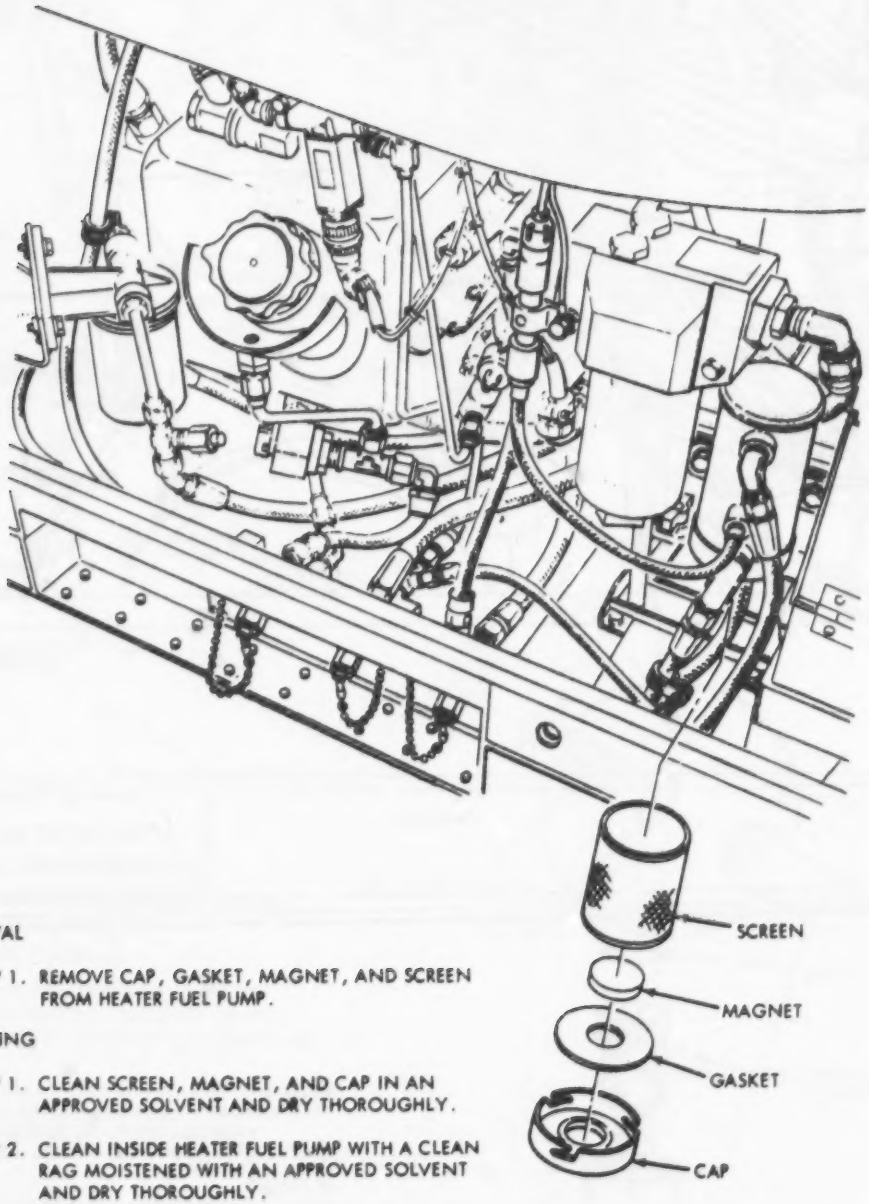
Figure 4-16. Heater fuel filter service.



REMOVAL

STEP 1. REMOVE CAP, GASKET, MAGNET, AND SCREEN FROM HEATER FUEL PUMP.

CLEANING

STEP 1. CLEAN SCREEN, MAGNET, AND CAP IN AN APPROVED SOLVENT AND DRY THOROUGHLY.

STEP 2. CLEAN INSIDE HEATER FUEL PUMP WITH A CLEAN RAG MOISTENED WITH AN APPROVED SOLVENT AND DRY THOROUGHLY.

INSTALLATION

STEP 1. INSTALL SCREEN, MAGNET, NEW GASKET, AND CAP IN REVERSE ORDER OF REMOVAL.

STEP 2. OPERATE PUMP AND CHECK FOR LEAKS.

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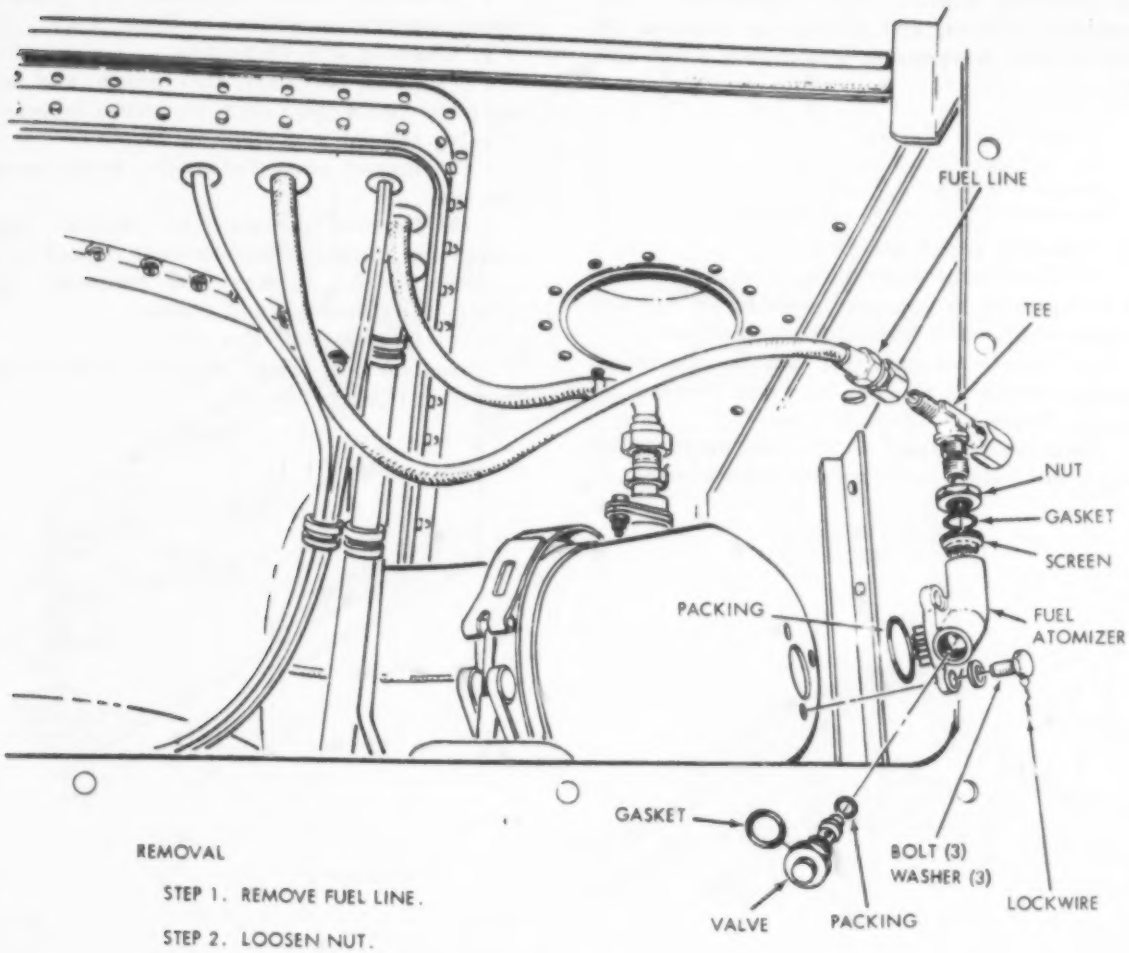
Figure 4-17. Heater fuel pump screen service.



REMOVAL

STEP 1. REMOVE FUEL LINE.

STEP 2. LOOSEN NUT.

STEP 3. REMOVE LOCKWIRE, BOLT (3), WASHER (3), FUEL ATOMIZER, AND PACKING.

STEP 4. REMOVE SCREEN.

STEP 5. REMOVE NUT AND GASKET.

STEP 6. REMOVE VALVE, PACKING, AND GASKET.

CLEANING

CLEAN SCREEN IN AN APPROVED SOLVENT AND DRY THOROUGHLY.

INSTALLATION

STEP 1. INSTALL THE FUEL ATOMIZER IN REVERSE ORDER OF REMOVAL USING NEW PACKINGS AND GASKETS.

STEP 2. OPERATE GENERATOR SET AND CHECK FOR LEAKS .

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Figure 4-18. Fuel atomizer screen service.

4-20. Tube Assemblies, Hose Assemblies, Clamps, and Fittings

a. Removal. Remove tube assemblies, hose assemblies, clamps, and fittings as required for access to other components or to replace a damaged part.

NOTE

Tag or otherwise identify connection points, routing, orientation of fittings, and location of supporting clamps for aid in reassembling.

b. Cleaning and Inspection.

(1) Clean tube assemblies, hose assemblies, and fittings with an approved cleaning solvent and dry thoroughly with filtered compressed air.

(2) Visually inspect for cracks, corrosion, abrasion, damaged threads, or other evidence of damage. Replace all damaged parts.

c. Installation. Install all removed hoses, tubes, clamps, and fittings in the reverse order of removal.

4-21. Auxiliary Fuel Pump and Motor Assembly

a. Removal. Remove auxiliary fuel pump and motor assembly as shown in figure 4-19.

b. Cleaning and Inspection.

(1) Clean auxiliary fuel pump and motor assembly with a clean cloth moistened in approved cleaning solvent and allow to dry.

(2) Inspect pump for cracks, breaks or other damage.

(3) Remove brushes as shown. Inspect brushes for pitting or uneven wear. Install brushes in same position as they were removed. Inspect springs for distortion and cracks.

(4) Replace defective parts.

c. Installation. Install auxiliary fuel pump as shown in figure 4-19.

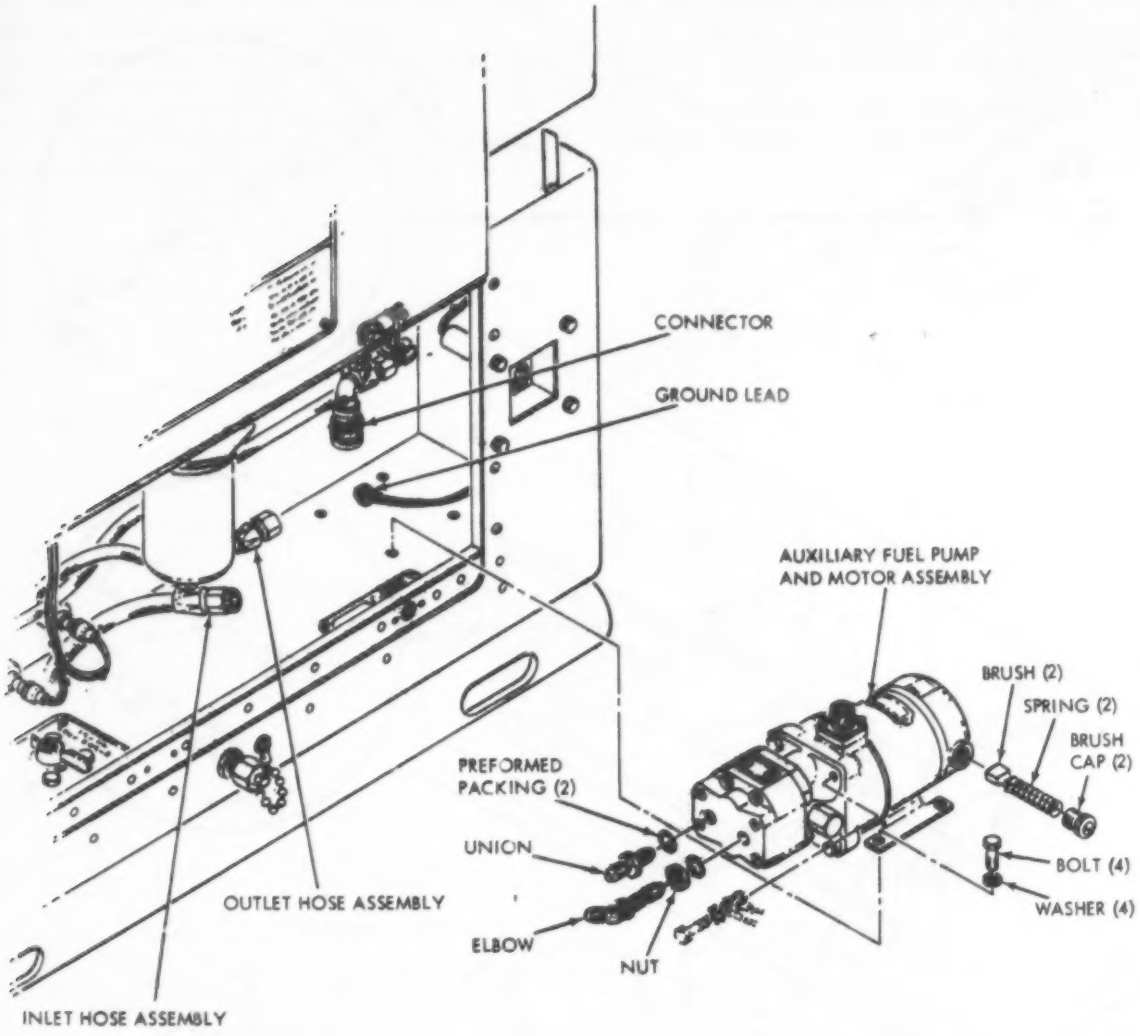

Figure 4-19. Auxiliary fuel pump and motor assembly removal and installation.

4-22. Fuel Tank Cap and Screen, and Fuel Level Gage

a. Removal. Remove fuel tank cap and fuel tank strainer, and fuel level gage as shown in figure 3-2.

b. Cleaning and Inspection. Clean the fuel tank cap and strainer in an approved solvent and dry thoroughly. Clean fuel level gage with a clean rag moistened in an approved solvent and dry thoroughly. Inspect for cracks, breaks, and other damage. Replace a defective cap, screen, or gage.

c. Installation. Install fuel tank cap and strainer and fuel level gage as shown in figure 3-2.

4-23. Fuel Selector, Fuel Drain, and Check Valves

a. Removal. Remove FUEL SELECTOR, FUEL DRAIN, and check valves as shown in figure 4-20.

b. Cleaning and Inspection. Clean the FUEL SELECTOR and FUEL DRAIN valves in approved solvent and dry thoroughly. Inspect valves for cracks, breaks, stripped threads, or other damage. Operate each valve handle and check for freedom of movement. Replace a defective valve.

c. Installation. Install FUEL SELECTOR and FUEL DRAIN valves as shown in figure 4-20.

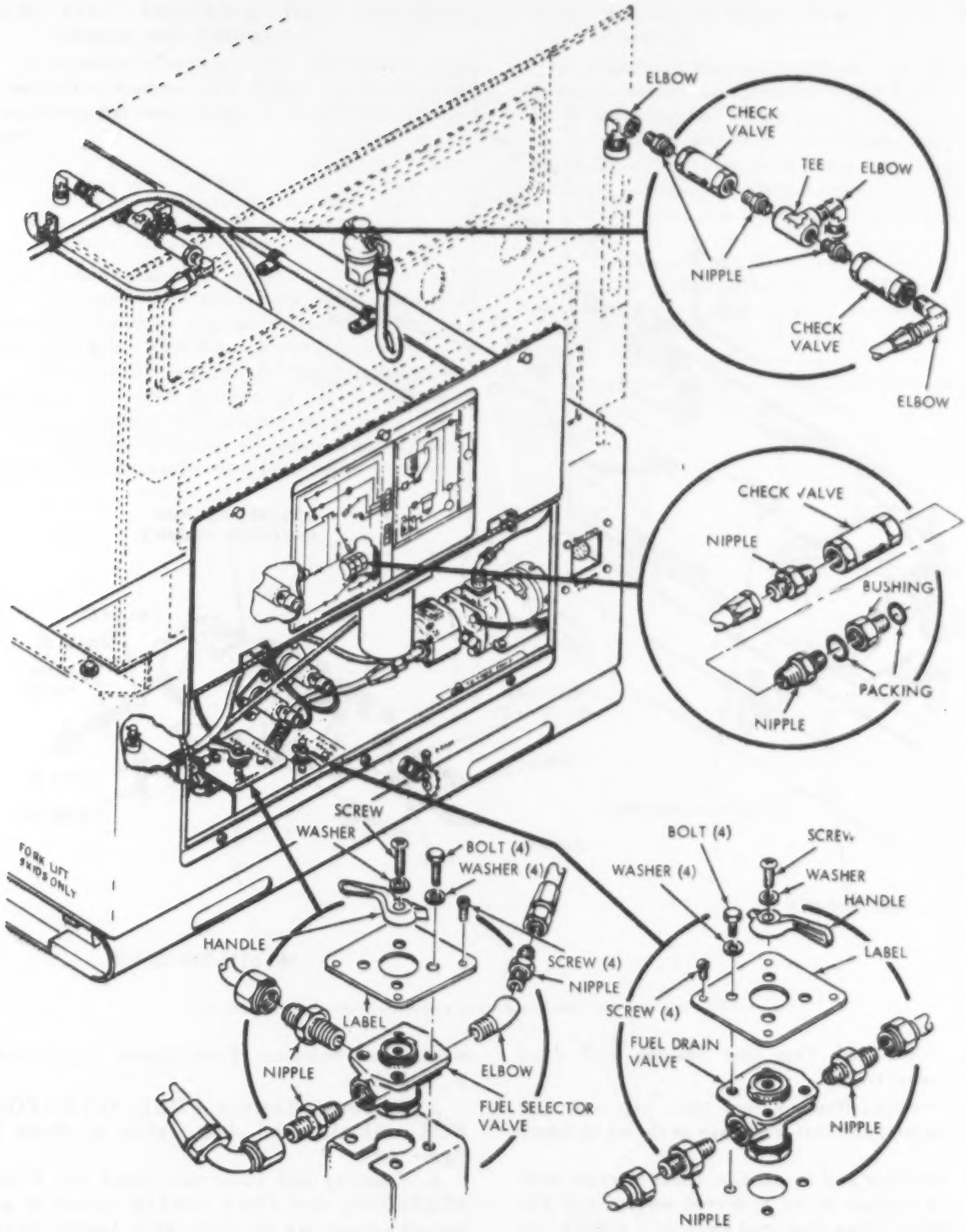

Figure 4-20. Fuel selector, fuel drain, and check valves, removal and installation.

4-24. Fuel Tank Fuel Filter Assembly

a. Removal. Remove fuel tank fuel filter assembly as shown in figure 4-21.

b. Disassembly. Disassemble fuel tank fuel filter assembly as shown.

c. Cleaning and Inspection.

(1) Clean all parts in an approved cleaning solvent and dry thoroughly.

(2) Inspect for cracks, breaks, or other damage. Discard element and packings.

d. Assembly. Assemble fuel tank fuel filter assembly with new packings and elements using figure as a guide.

e. Installation. Install fuel tank fuel filter assembly as shown in figure 4-21.

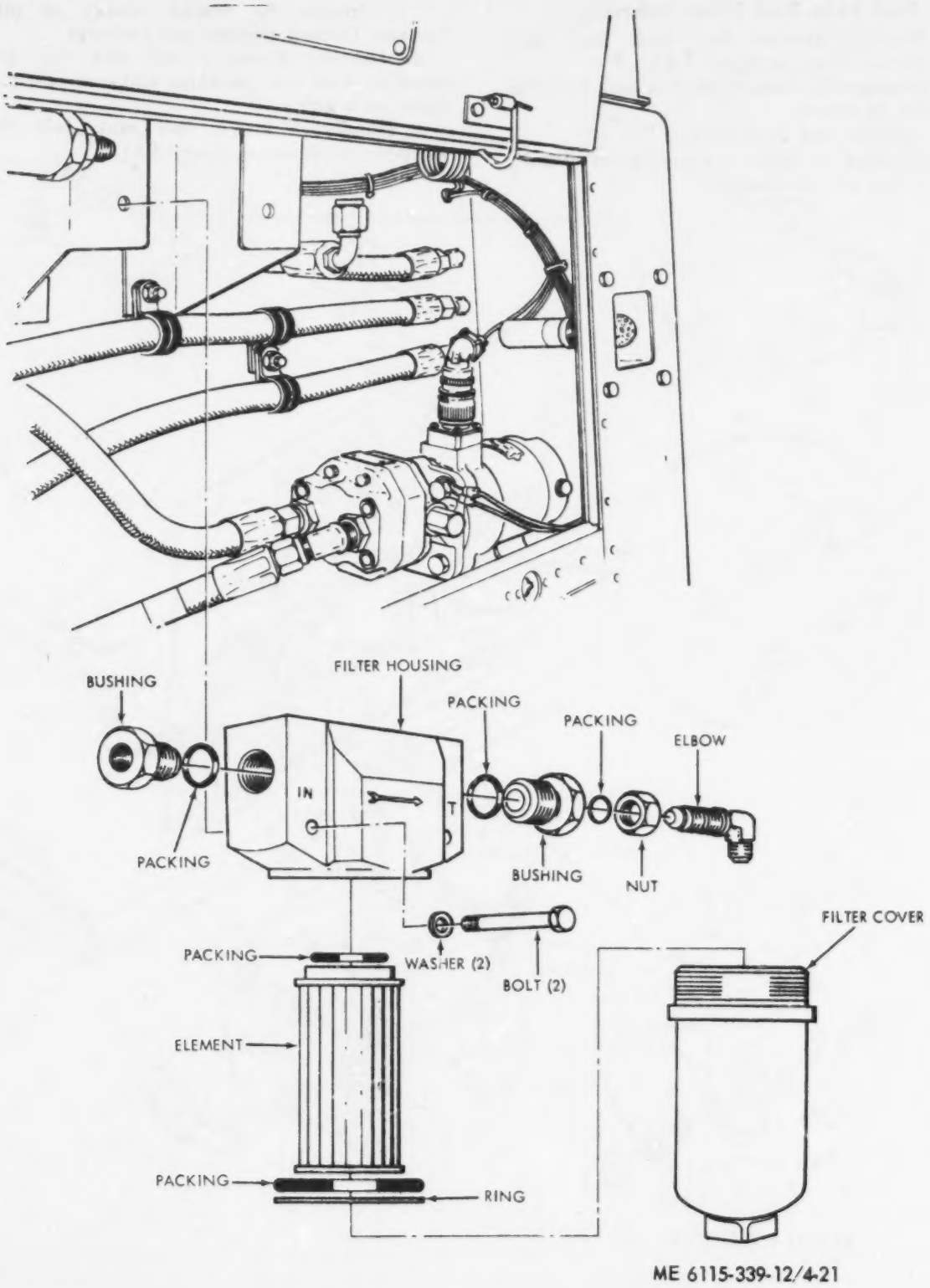

Figure 4-21. Fuel tank fuel filter, removal, disassembly, reassembly, and installation.

4-25. Main Fuel Pump and Motor Assembly

a. Removal. Remove main fuel pump and motor assembly as shown in figure 4-22.

b. Cleaning and Inspection.

(1) Clean main fuel pump and motor assembly with a clean cloth moistened in approved cleaning solvent and allow to dry.

(2) Inspect pump for cracks, breaks, or other damage.

(3) Remove brushes as shown in figure. Inspect brushes for pitting or uneven wear. Install brushes in same position as they were removed. Inspect springs for distortion and cracks.

(4) Replace defective parts.

c. Installation. Install main fuel pump and motor assembly as shown in figure 4-22.

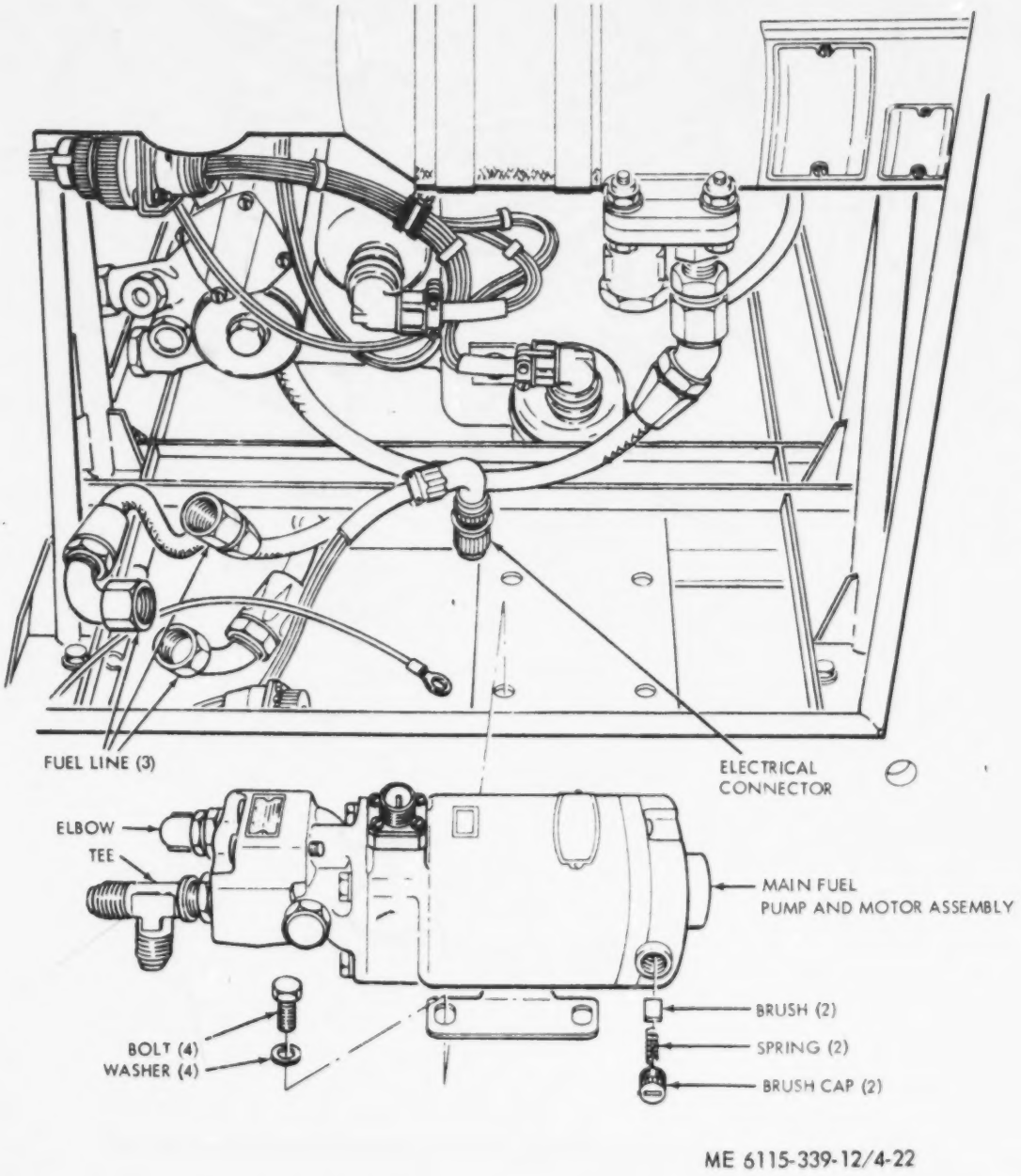

Figure 4-22. Main fuel pump and motor assembly, removal and installation.

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4-26. Main Fuel Filter Assembly

a. Removal. Remove main fuel filter assembly as shown in figure 4-23.

b. Disassembly. Disassemble main fuel filter assembly as shown in figure.

c. Cleaning and Inspection.

(1) Clean all parts in approved cleaning solvent and dry thoroughly.

(2) Inspect for cracks, breaks, or other damage. Discard packing.

d. Assembly. Assemble main fuel filter assembly with new packing as shown in figure.

e. Installation. Install main fuel filter assembly as shown in figure 4-23.

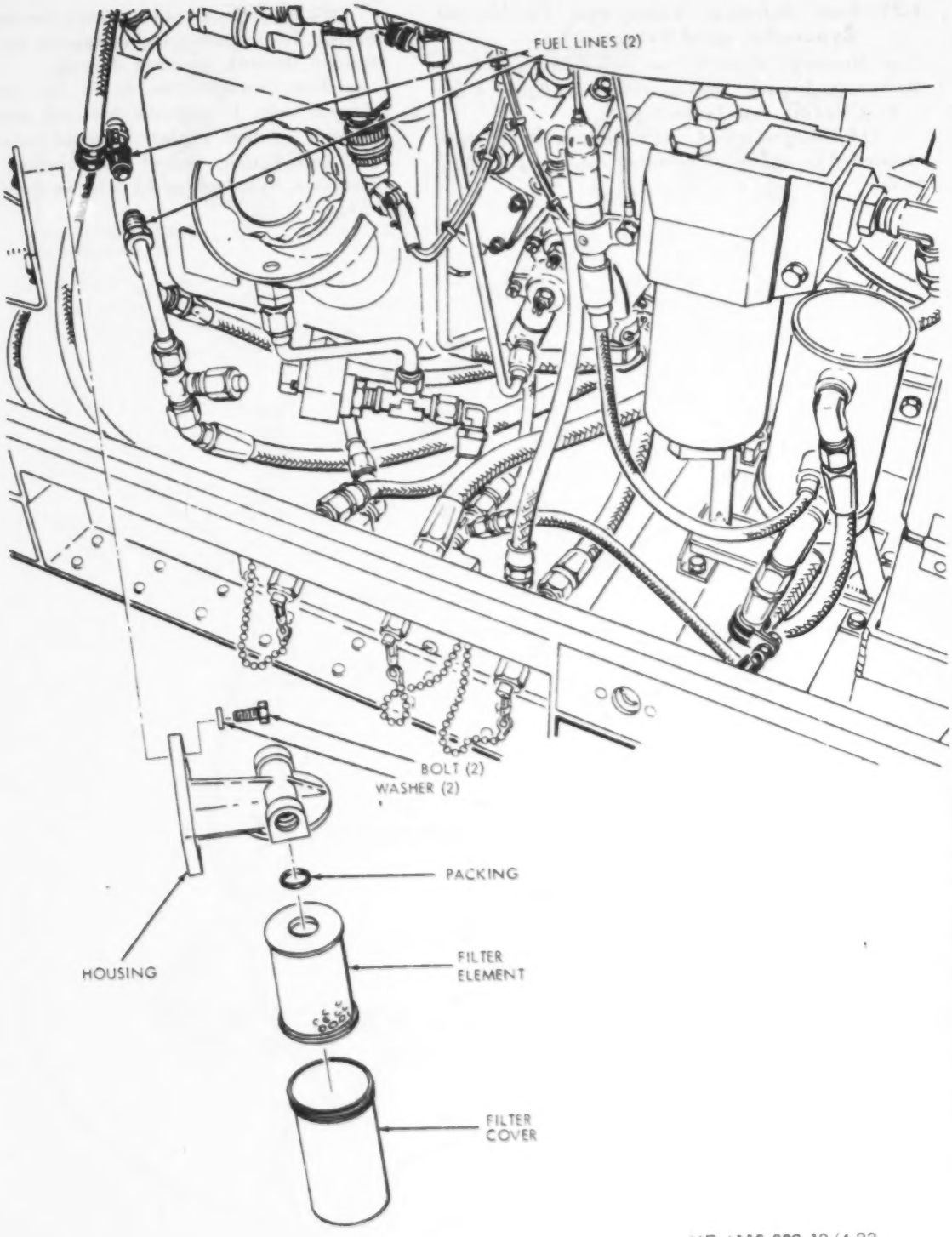


Figure 4-23. Main fuel filter assembly, removal, disassembly, reassembly, and installation.

4-27. Fuel Solenoid Valve and Thermostat Bypass Solenoid Valves

a. Removal. Remove fuel solenoid valve and thermostat bypass valve as shown in figure 4-24.

b. Cleaning and Inspection.

(1) Clean solenoid valves with a clean cloth moistened in approved cleaning solvent and allow to dry.

(2) Inspect valves for cracks, breaks, or other damage. Inspect electrical connector for bent pins, stripped threads, or other damage.

c. Test. Connect 24v dc to the terminals of solenoid coils. If solenoid does not actuate when power is applied, replace solenoid valve.

d. Installation. Install fuel solenoid valve and thermostat bypass solenoid valve as shown in figure 4-24.

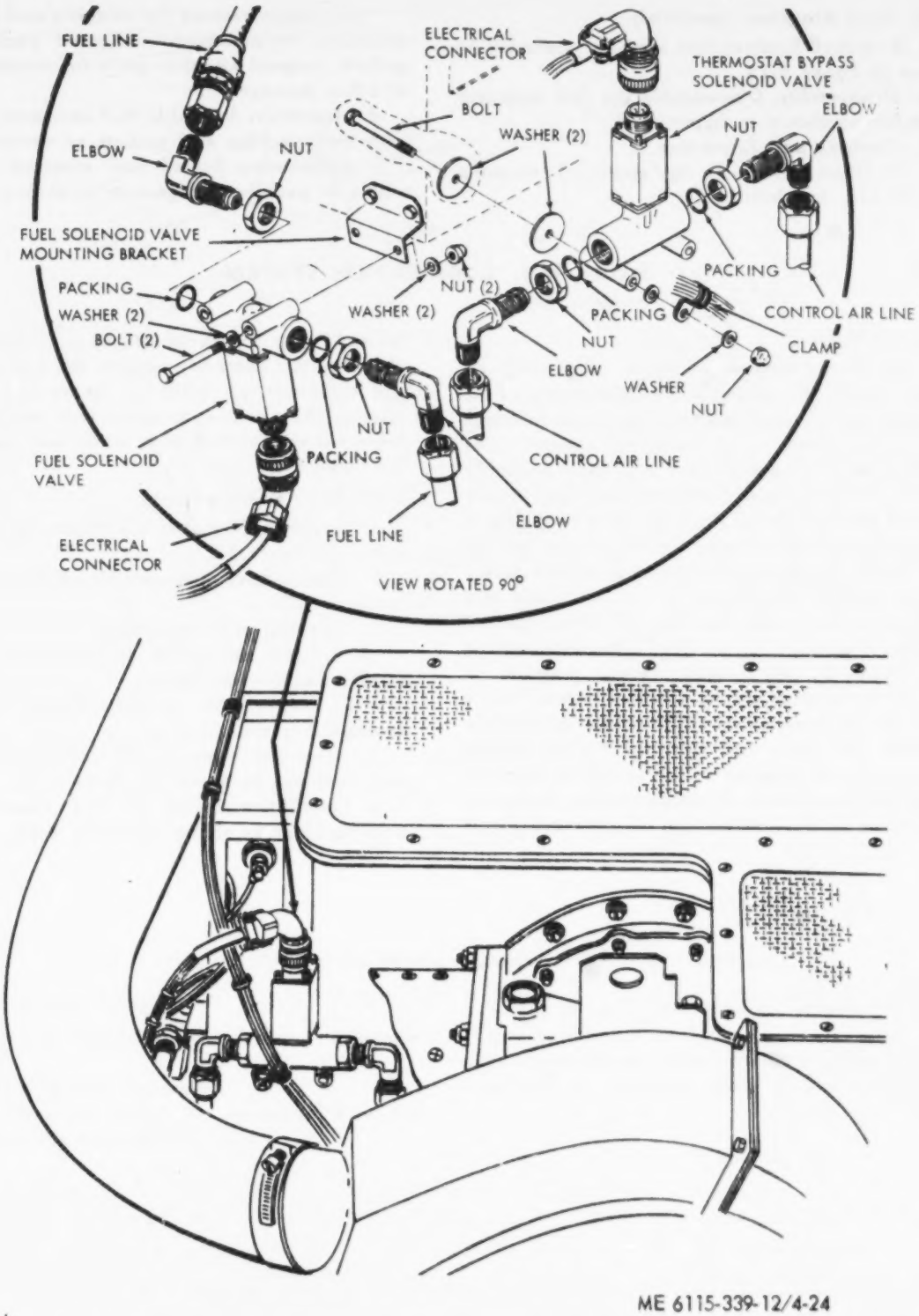


Figure 4-24. Fuel solenoid valve and thermostat bypass solenoid valve, removal and installation.

4-28. Fuel Atomizer Assembly

a. Removal. Remove fuel atomizer assembly as shown in figure 4-18.

b. Disassembly. Disassemble the fuel atomizer assembly as shown in figure 4-18.

c. Cleaning and Inspection.

(1) Clean all parts in approved cleaning solvent and dry thoroughly.

(2) Inspect screen for clogging and breaks. If defective, replace screen. Discard packings and gaskets. Inspect all other parts for cracks, breaks, or other damage.

d. Assembly. Assemble fuel atomizer assembly with new packing and gaskets as shown.

e. Installation. Install fuel atomizer assembly with new packing and gaskets as shown in figure.

Section VIII. LUBRICATION SYSTEM

4-29. General

The lubricating system provides lubricating oil under pressure to cool and lubricate the gears of the accessory drive section and the high speed bearings of the compressor and turbine sections. The lubricating oil is drawn from the oil tank assembly by the oil pump assembly and supplied under pressure through the oil filter assembly to the gears and bearings. A safety bypass valve is built into the body of the oil filter assembly to provide a safety bypass for the lubricating oil to the gears and bearings in the event that the oil filter element becomes clogged. An oil pressure sequencing switch is actuated by the lubricating oil pressure to energize the ignition system and fuel solenoid valve when the oil pressure is sufficient to adequately lubricate the gears and bearings during engine start. A low oil pressure switch is incorporated in the lubrication system to automatically shutdown the engine if the lubricating oil pressure drops below 55 psig. A scavenge pump an integral part of the oil pump assembly returns the lubricating oil and entrained air from the gears and bearings through the oil cooler to the oil tank assembly. The entrained air is vented from the oil tank assembly to the turbine exhaust.

4-30. Oil Filter Assembly

a. Removal. Remove oil filter assembly as shown in figure 4-25.

b. Disassembly. Disassemble oil filter as shown in figure 4-25.

c. Cleaning and Inspection.

(1) Clean all parts in approved cleaning solvent and dry thoroughly.

(2) Inspect for cracks, breaks, or other damage. Discard packings.

d. Assembly. Assemble oil filter assembly with new packings as shown in figure 4-25.

e. Installation. Install oil filter assembly with new packings as shown in figure 4-25.

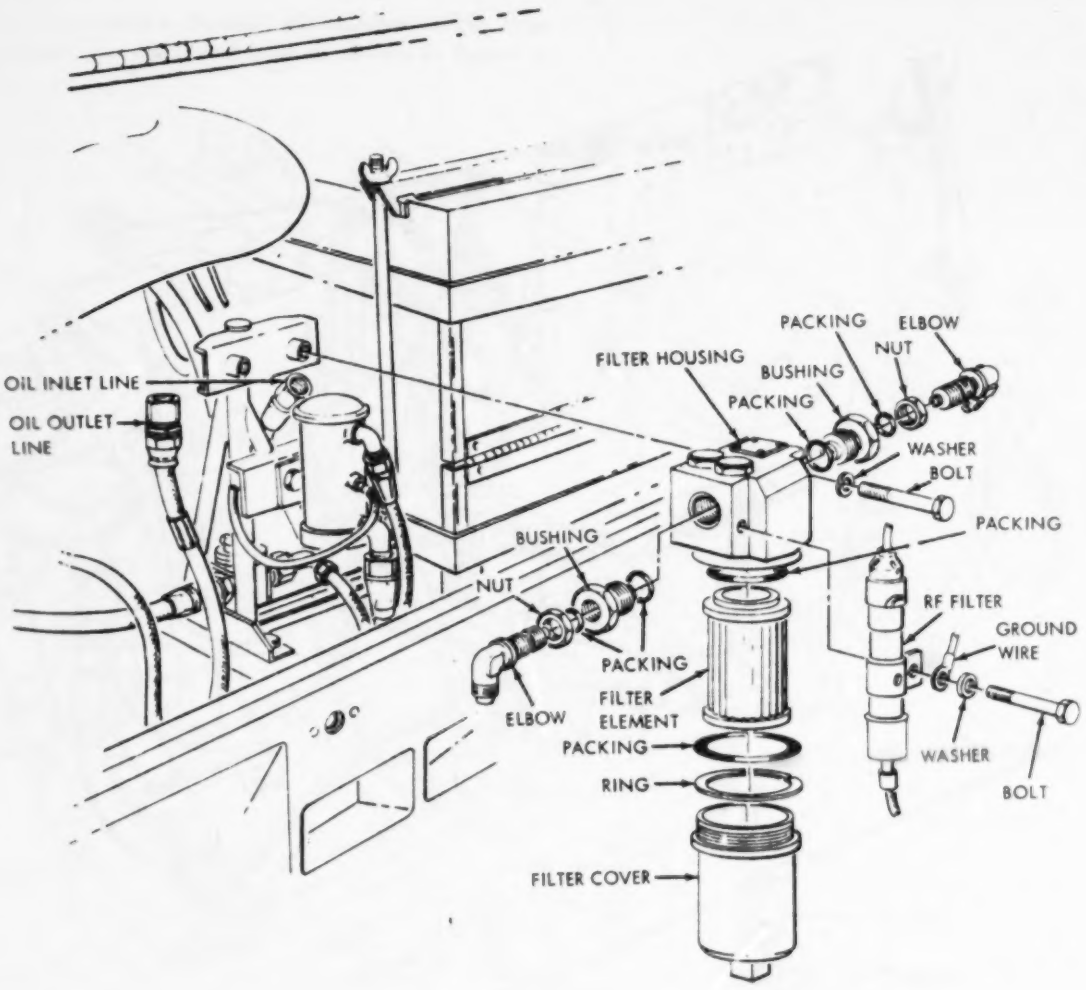


Figure 4-25. Oil filter assembly, removal, disassembly, reassembly and installation.

4-31. Oil Drain Valve

a. Removal. Remove oil drain valve as shown in figure 4-26.

b. Cleaning and Inspection.

(1) Clean all parts in approved cleaning solvent and dry thoroughly.

(2) Inspect for cracks, breaks, or other damage. Discard packings.

c. Installation. Install oil drain valve with new packings as shown in figure 4-26.

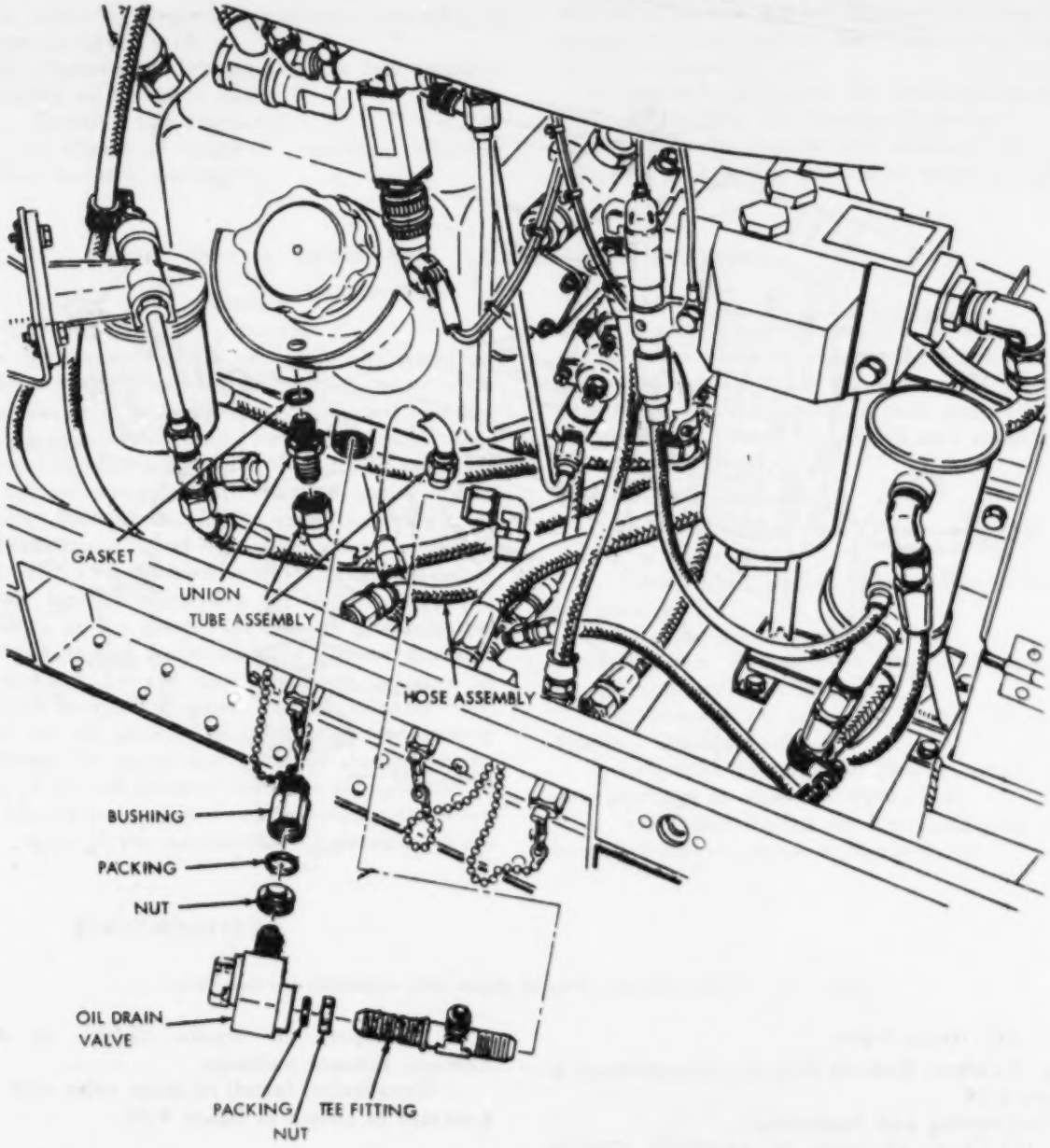


Figure 4-26. Oil drain valve removal and installation.

4-32. Oil Tank Screen

a. Removal. Remove oil tank screen as shown in figure 3-1.

b. Cleaning and Inspection.

(1) Clean all parts in approved solvent and dry thoroughly.

(2) Inspect for clogged screen and for cracks, breaks, and other damage.

c. Installation. Install oil tank screen as shown in figure 3-1.

4-33. Oil Cooler and Oil Cooler Air Duct and Hose

a. Removal. Remove oil cooler, air duct, and hose as shown in figure 4-27.

b. Cleaning and Inspection.

(1) Clean all parts with approved cleaning solvent and dry thoroughly.

(2) Inspect for cracks, breaks, or other damage. Discard packings.

c. *Installation.* Install oil cooler with new packings, air duct, and hose as shown in figure 4-27.

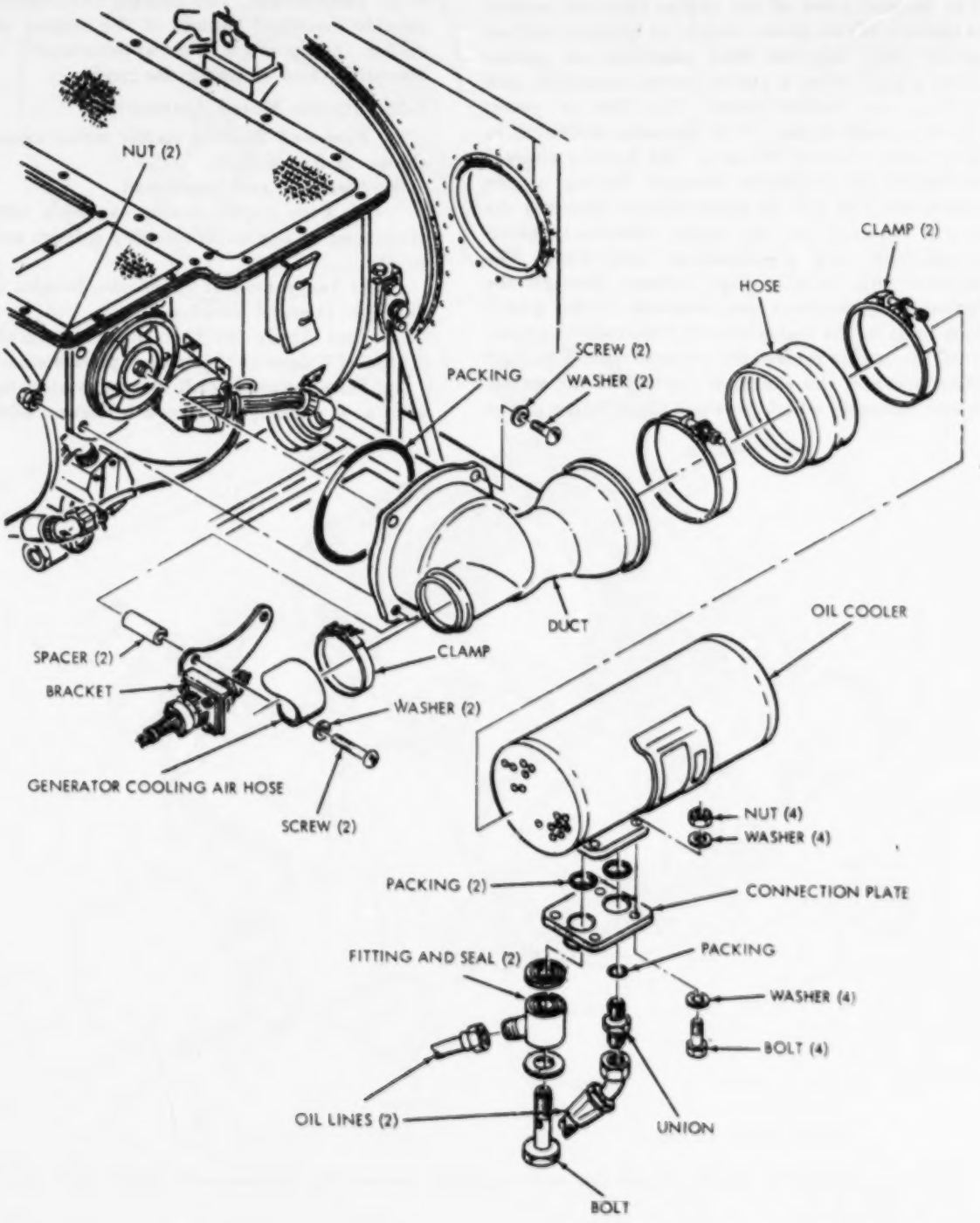


Figure 4-27. Oil cooler, oil cooler air duct and hose, removal and installation.

Section IX. ENGINE ELECTRICAL SYSTEM

4-34. General

The integral parts of the engine electrical system includes a 24v dc power circuit, an ignition unit, an igniter plug electrical lead assembly, an igniter plug, a start relay, a starter motor assembly, and holding and control relays. The 24v dc power circuit consists of two 12v dc batteries connected in series and a battery charger. The battery charger maintains the batteries charged during engine operation. The 24v dc power circuit provides the power required by the engine electrical system components and winterization equipment. The ignition unit supplies high voltage through the igniter plug electrical lead assembly to the igniter plug to ignite the fuel mixture for the turbine engine until the engine reaches 95 percent rpm. The start relay provides the electrical control of the starter motor assembly which provides the rotating power for starting the engine until the engine accelerates to 35 percent rpm. The holding and control relays provide electrical control of the engine electrical system components for automatically starting operating, and stopping the engine.

4-35. Starter Motor Assembly

a. Removal. Remove starter motor assembly as shown in figure 4-28.

b. Cleaning and Inspection.

(1) Wipe starter motor assembly with cloth moistened in approved cleaning solvent and allow to dry.

(2) Inspect motor for cracks, breaks, or other damage. Discard packing.

c. Test. Apply 24v dc to the terminals of starter motor. If it does not operate, replace starter motor.

d. Installation. Install starter motor assembly with new packing as shown in figure 4-28.

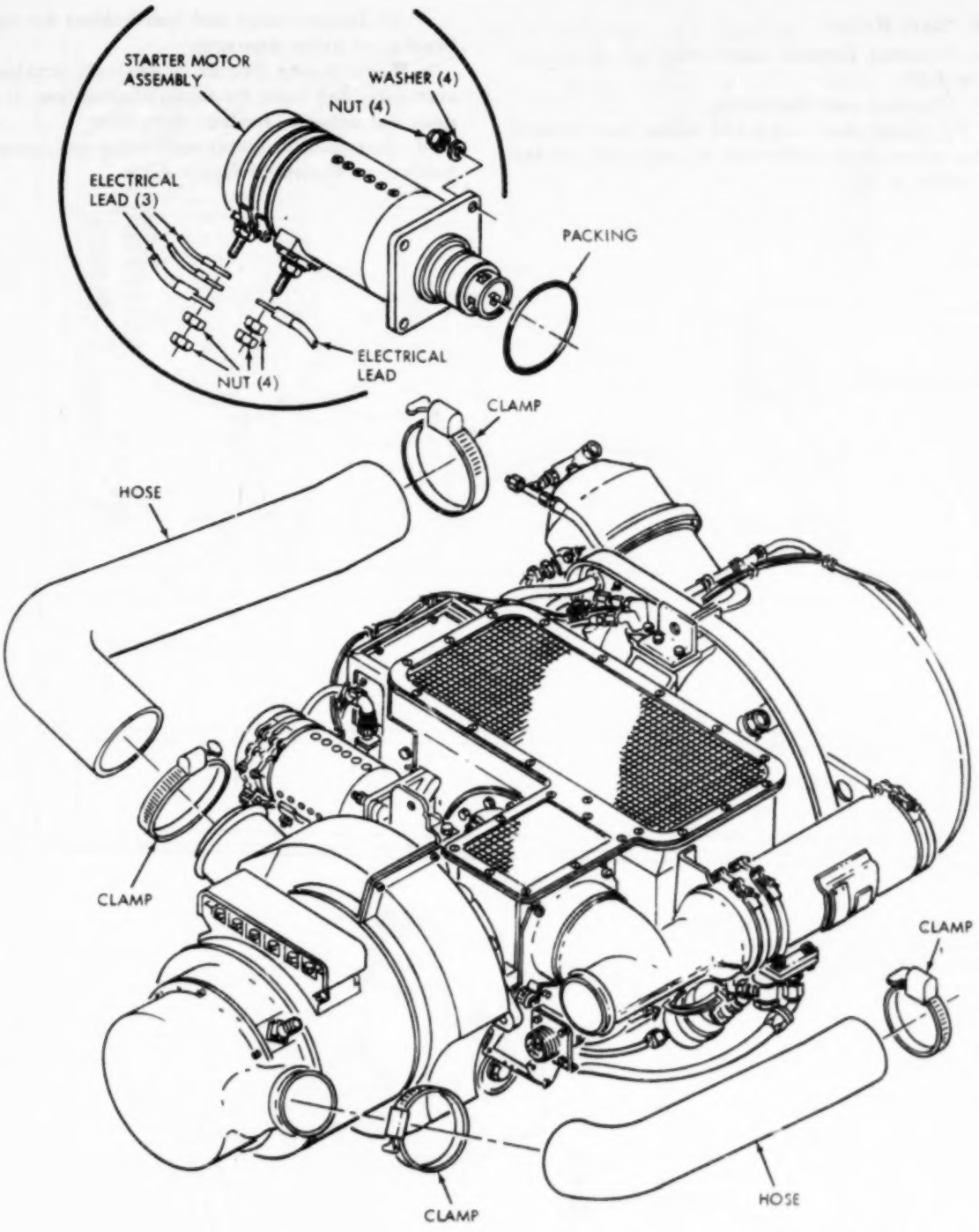


Figure 4-28. Starter motor assembly and generator cooling air hose and clamps, removal and installation.

4-36. Start Relay

a. Removal. Remove start relay as shown in figure 4-29.

b. Cleaning and Inspection.

(1) Clean start relay and spare fuse holders with a clean cloth moistened in approved solvent and allow to dry.

(2) Inspect relay and fuse holders for cracks, breaks, or other damage.

c. Test. Apply 24v dc to the coil terminals of start relay and listen for sound of actuation. If relay does not actuate, replace start relay.

d. Installation. Install start relay and spare fuse holders as shown in figure 4-29.

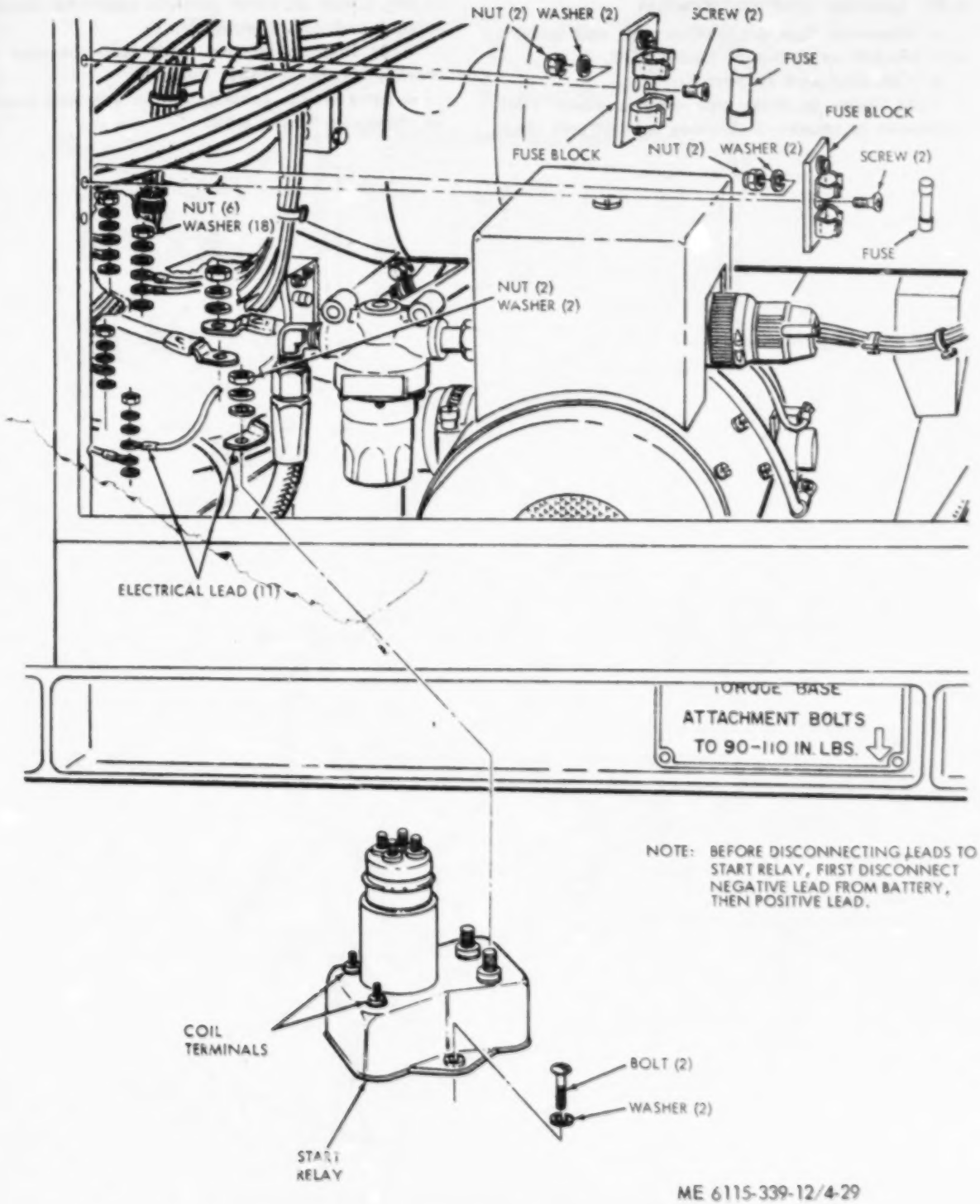


Figure 4-29. Start relay, removal and installation.

4-37. Ignition Unit and Bracket

a. Removal. Remove ignition unit and ignition unit bracket as shown in figure 4-30.

b. Cleaning and Inspection.

(1) Clean ignition unit with a clean cloth moistened in approved cleaning solvent and allow to dry. Clean all other parts in approved cleaning solvent and dry thoroughly.

(2) Inspect ignition unit and bracket for cracks, breaks or other damage.

c. Installation. Install ignition unit and bracket as shown in figure 4-30.

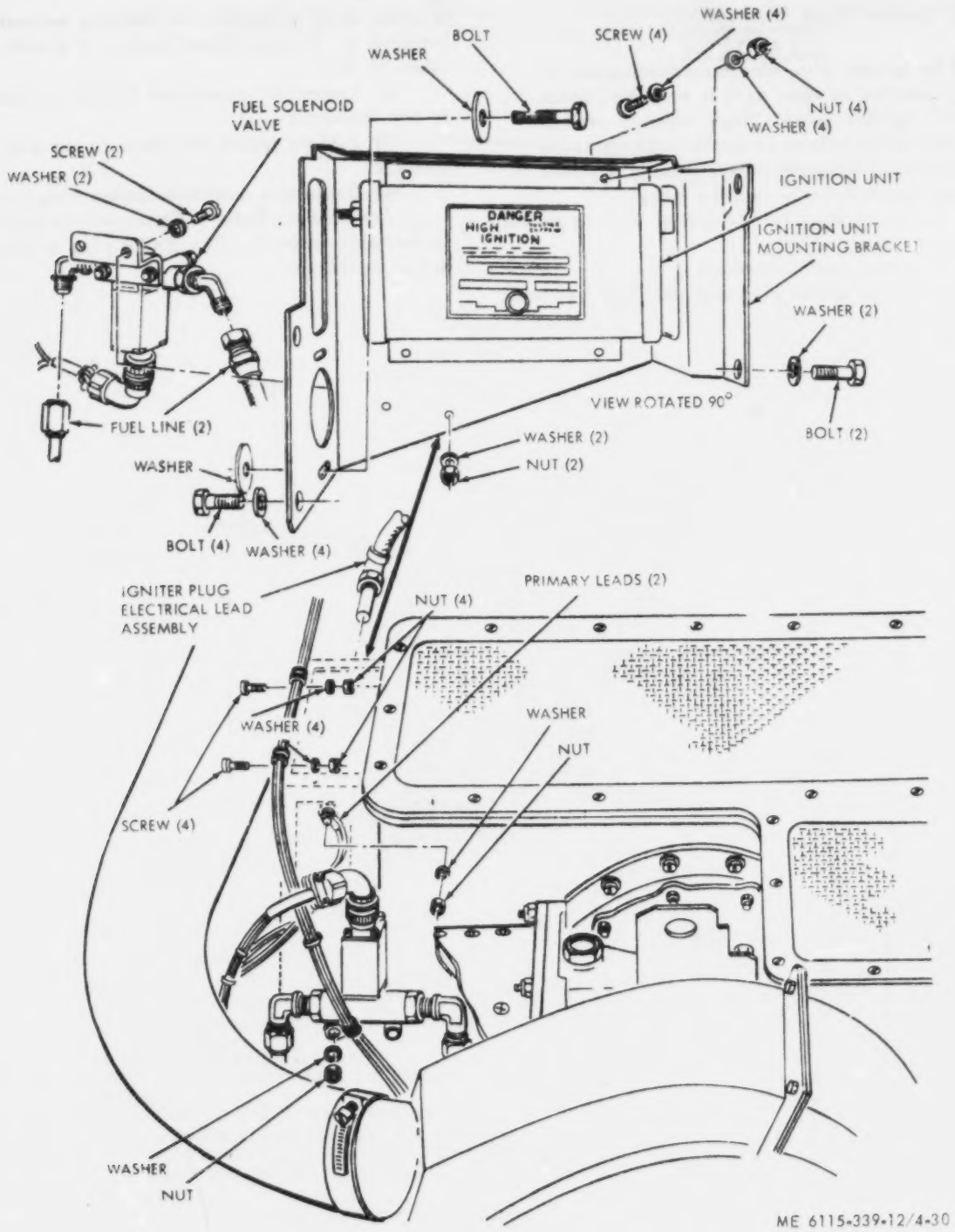


Figure 4-30. Ignition unit and bracket, removal and installation.

4-38. Igniter Plug Assembly

WARNING

The igniter plug electrical lead must be grounded as soon as it is removed from the igniter plug. High voltage which may cause injury or death is likely to be present. Ground by touching control spring in lead to igniter plug.

a. Removal. Remove the igniter plug as shown in figure 4-31.

b. Cleaning and Inspection.

(1) Clean igniter plug and electrical lead with a clean cloth moistened in cleaning solvent conforming to Federal Specification P-D-680, and allow to dry.

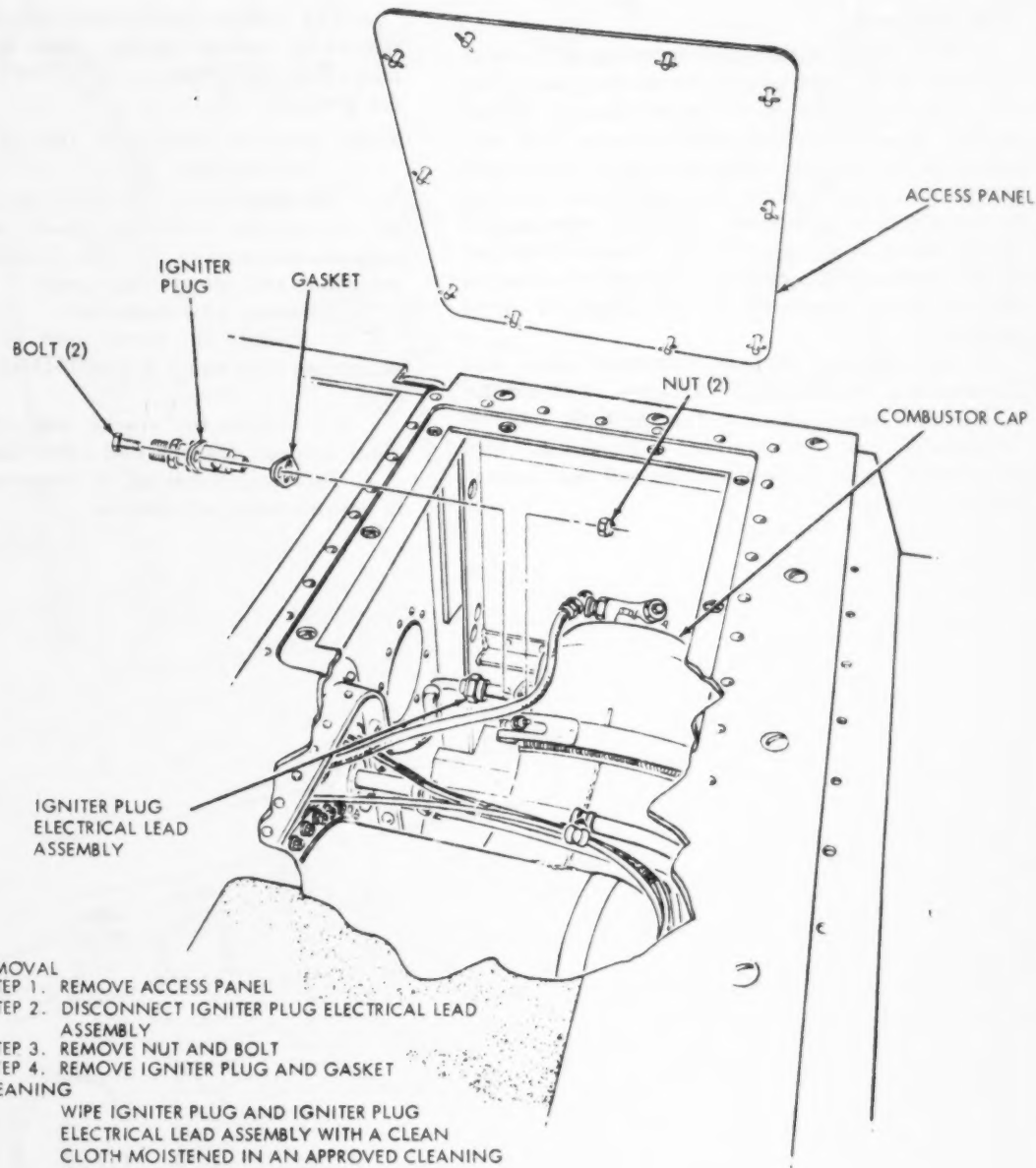
(2) Inspect for cracks and breaks, particularly in the insulation.

(3) Inspect gasket for deterioration and other damage.

(4) Replace a defective igniter plug.

c. Installation. Refer to figure 4-31 to install the igniter plug assembly. The igniter plug is tested by actual operation.

WARNING: GROUND IGNITER PLUG ELECTRICAL LEAD ASSEMBLY BY TOUCHING CONTROL SPRING IN LEAD TO IGNITER PLUG AS SOON AS LEAD IS REMOVED. HIGH VOLTAGES ARE LIKELY STILL PRESENT.



REMOVAL
STEP 1. REMOVE ACCESS PANEL
STEP 2. DISCONNECT IGNITER PLUG ELECTRICAL LEAD ASSEMBLY
STEP 3. REMOVE NUT AND BOLT
STEP 4. REMOVE IGNITER PLUG AND GASKET

CLEANING
WIPE IGNITER PLUG AND IGNITER PLUG ELECTRICAL LEAD ASSEMBLY WITH A CLEAN CLOTH MOISTENED IN AN APPROVED CLEANING SOLVENT AND DRY THOROUGHLY.

INSTALLATION
INSTALL IGNITER PLUG AND ELECTRICAL LEAD ASSEMBLY IN REVERSE ORDER OF REMOVAL.

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Figure 4-31. Igniter plug assembly removal and installation.

Section X. ENGINE CONTROLS, ELECTRICAL CONTROLS, INSTRUMENT PANELS AND VOLTAGE DISTRIBUTION PANEL ASSEMBLY COMPONENTS

4-39. General

a. The engine controls instrument panel contains the controls and instruments for starting, stopping, and monitoring the operation of the gas turbine engine. In addition, the panel contains a dc ammeter, in the battery charging circuit and circuit breakers to protect both the internal and external dc circuits. The tachometer indicator also located on the panel, is actuated by the voltage developed by the tachometer generator, which is mounted on the oil pump assembly in the accessory drive section.

b. The electrical controls instrument panel and the electrical equipment rack (located behind the instrument panel) contain the controls and instruments for adjustment, operation, and monitoring of ac power system and the battery heater circuits.

c. The voltage distribution panel contains the removable voltage change panel that is used to select 240 / 416 volts or 120 / 208 volts output of the generator set.

4-40. Engine Controls Instrument Panel Components

a. Removal. Refer to figure 4-32 and remove the tachometer indicator circuit breakers, start counter, master switch, time totalizing meter, dc ammeter, and oil pressure gage.

b. Cleaning and Inspection.

(1) Clean all parts with a clean cloth moistened in cleaning solvent P-D-680 and allow to dry.

(2) Inspect for cracks and breaks, broken glass stripped threads and other damage.

c. Installation. Install all removed components in reverse order of removal.

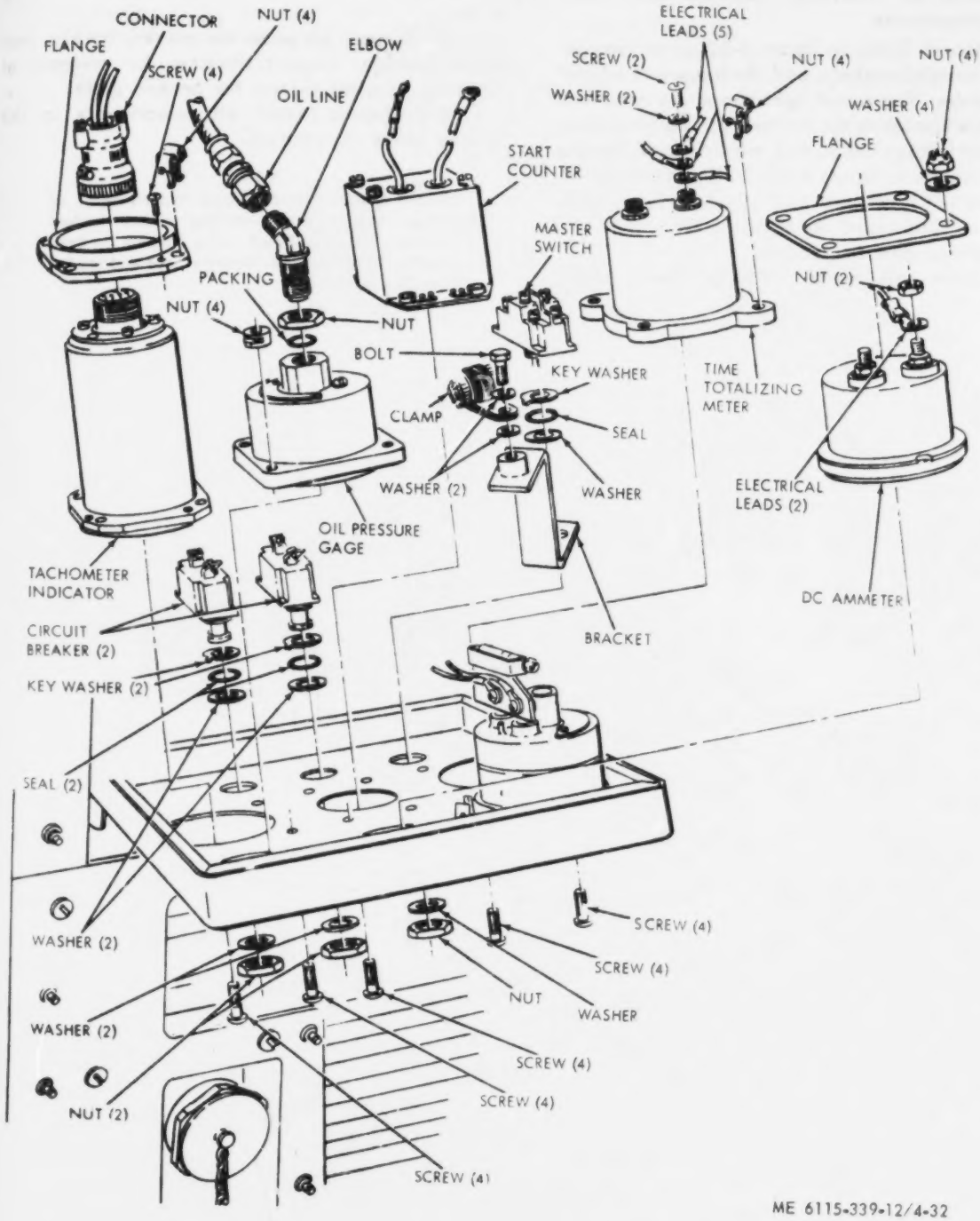

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Figure 4-32. Engine controls instrument panel components, removal and installation.

4-41. Electrical Controls Instrument Panel Components

a. Removal. Refer to figure 4-33(1) to remove switches, circuit breakers, and the frequency adjust potentiometer. The panel light lamps are removed in a manner similar to the removal of synchronizing lamps, overvoltage lamp, and winterization heater lamps as shown in figure 4-33(2). The removal of the voltmeter, ammeter, and synchronizing light resistors are illustrated by figure 4-33(3).

b. Cleaning and Inspection.

(1) Clean all parts with a clean cloth moistened with cleaning solvent P-D-680 and allow to dry.

(2) Inspect all parts for cracks, breaks, and other damage. Inspect resistors for evidence of charring. Inspect meters for broken glass.

c. Installation. Install all components in the reverse order of removal.

NOTE

Do not connect electrical lead to terminal 3 of remote local voltage sensing switch unless operation is anticipated using remote voltage sensing. Wrap lead with electrical tape and tag for identification.

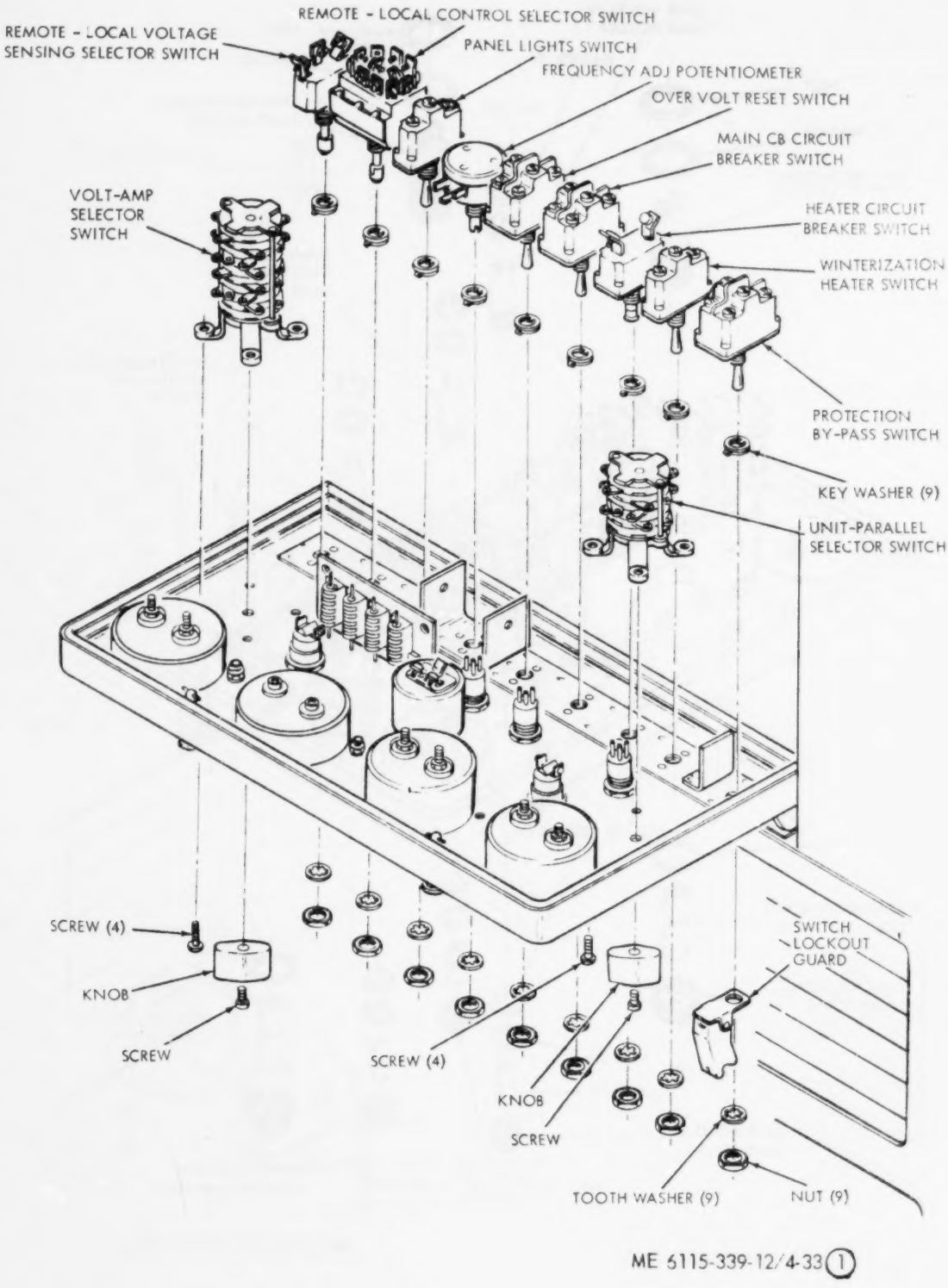


Figure 4-33. Electrical controls instrument panel components, removal and installation (sheet 1 of 3).

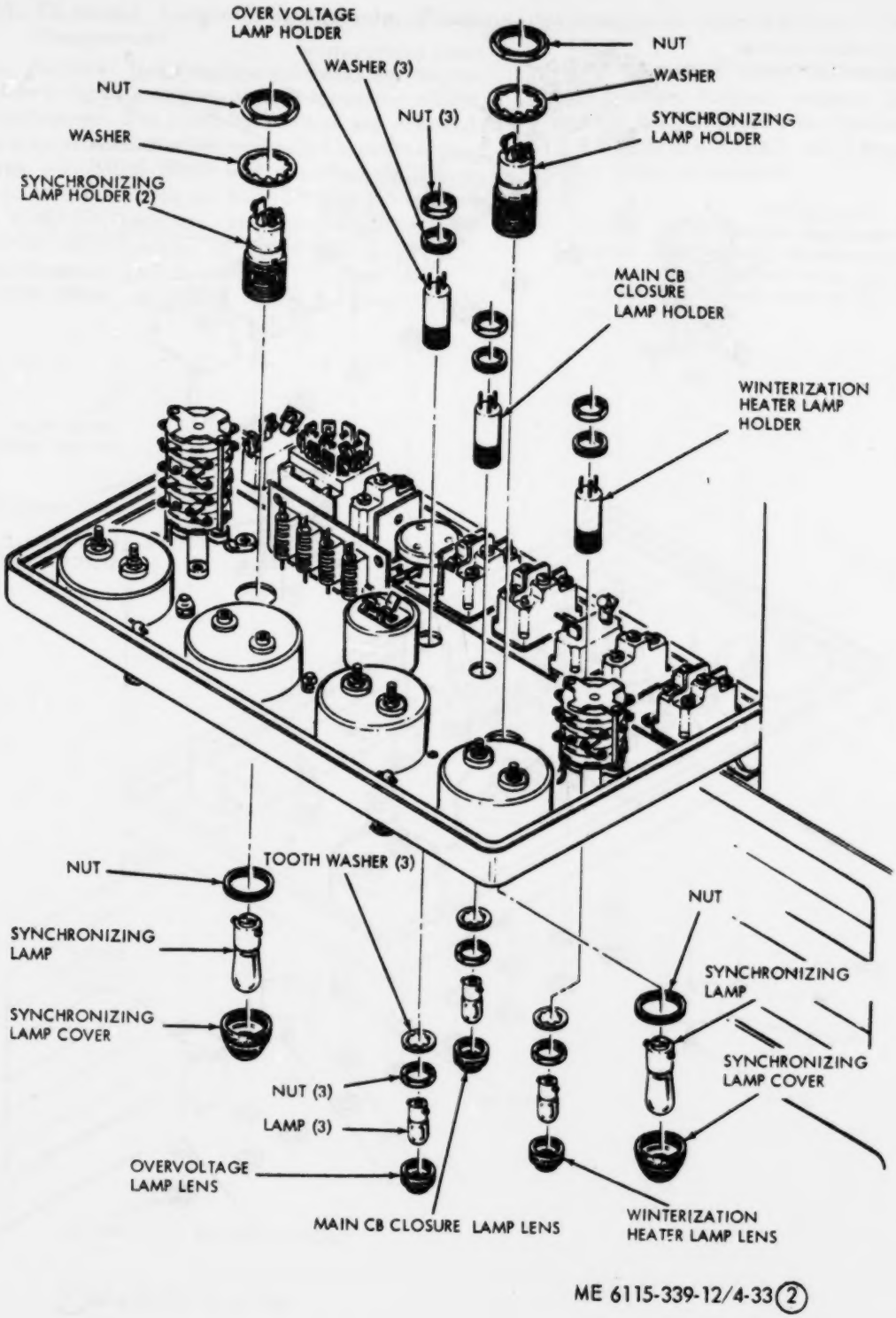


Figure 4-33. Electrical controls instrument panel components, removal and installation (sheet 2 of 3).

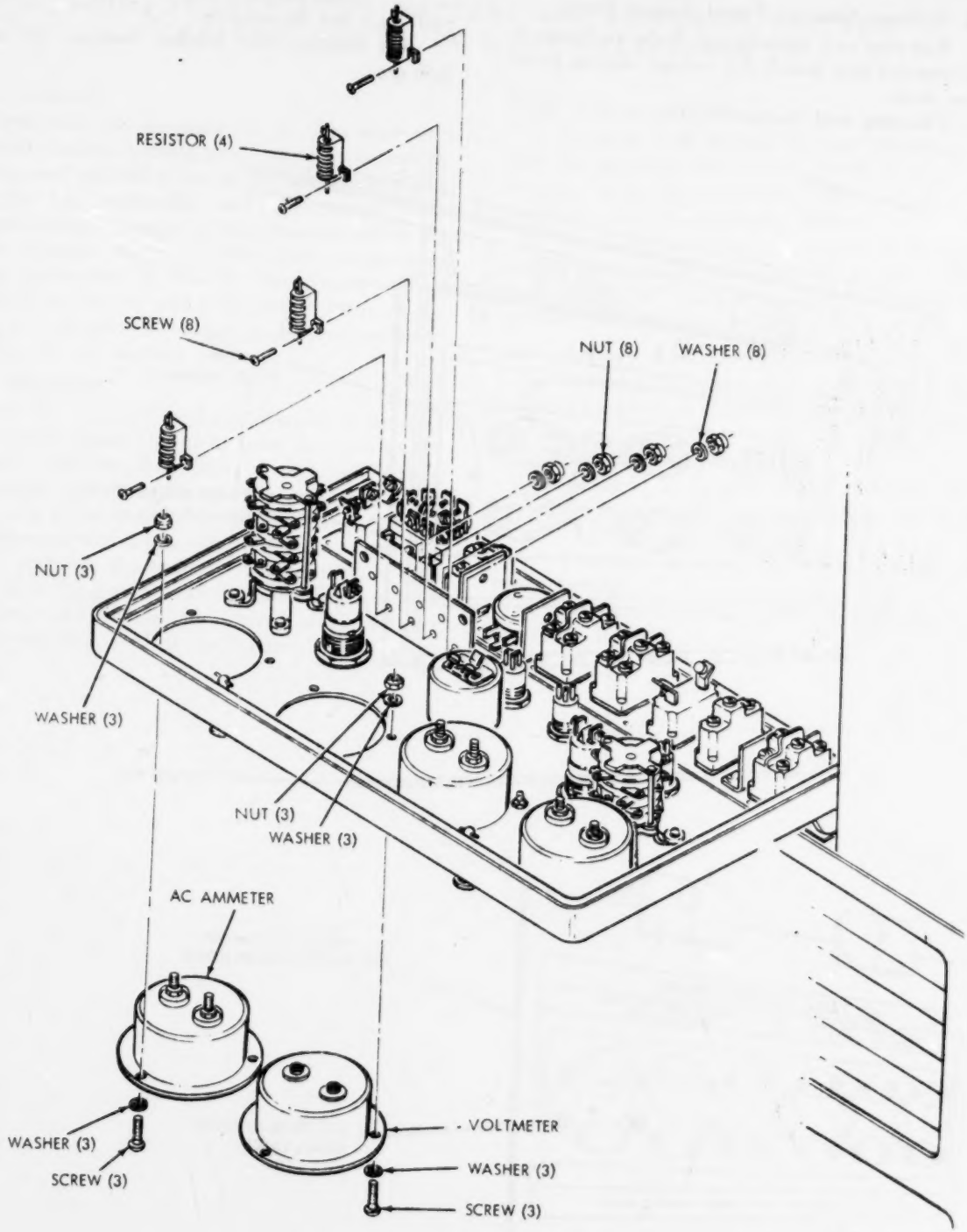


Figure 4-33. Electrical controls instrument panel components, removal and installation (sheet 3 of 3).

4-42. Voltage Change Panel Access Door

a. Removal and Installation. Refer to figure 4-34 to remove and install the voltage change panel access door.

b. Cleaning and Inspection.

(1) Clean all parts with cleaning solvent (P-D-680) and dry thoroughly.

(2) Inspect for cracks, breaks, or other damage.

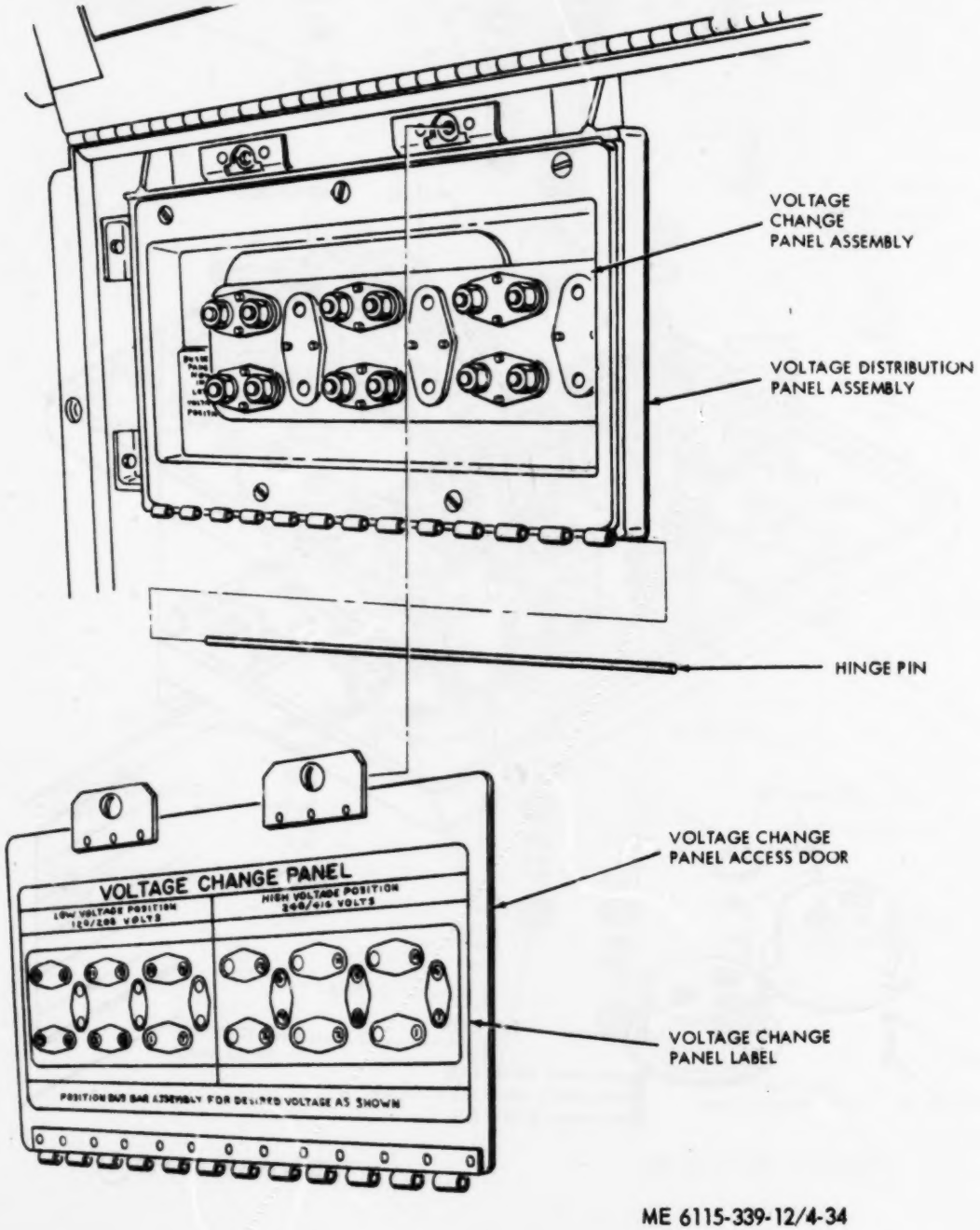


Figure 4-34. Voltage change panel access door, removal and installation.

Section XI. BATTERIES, BATTERY BOX ASSEMBLY, BATTERY CHARGER, AND 24V DC SLAVE RECEPTACLE J15

4-43. General

The batteries are installed in an insulated and externally heated battery box assembly to provide starting and operating power for the engine. The batteries are recharged and maintained fully charged during operation of the generator set by the battery charger, which receives input power from the ac generator. A 24v dc slave receptacle is provided for battery charging power from an external 24v dc battery charger, or for connection of external 24v dc starting power.

4-44. Batteries

Remove the 11 vent caps and battery electrolyte temperature sensor (fig. 2-1) from the cells of the batteries. Test the electrolyte of each cell with a hydrometer and note the specific gravity reading (para 2-1). If the average specific gravity for all the cells indicates that the battery is 50 percent charged or less, recharge the battery. If one or more cells have a specific gravity reading indicating less than half charge and this reading is much lower than the average reading, replace the battery (fig. 2-1).

4-45. Battery Charger

a. General. The normal battery charging rate with the generator set running varies from 2 to 5 amperes with a fully charged battery to about 10 amperes with a low-charged battery.

b. Inspection. Visually inspect the battery charger for damage to enclosure and other obvious damage. Report damage to direct support maintenance personnel.

4-46. Battery Box Assembly

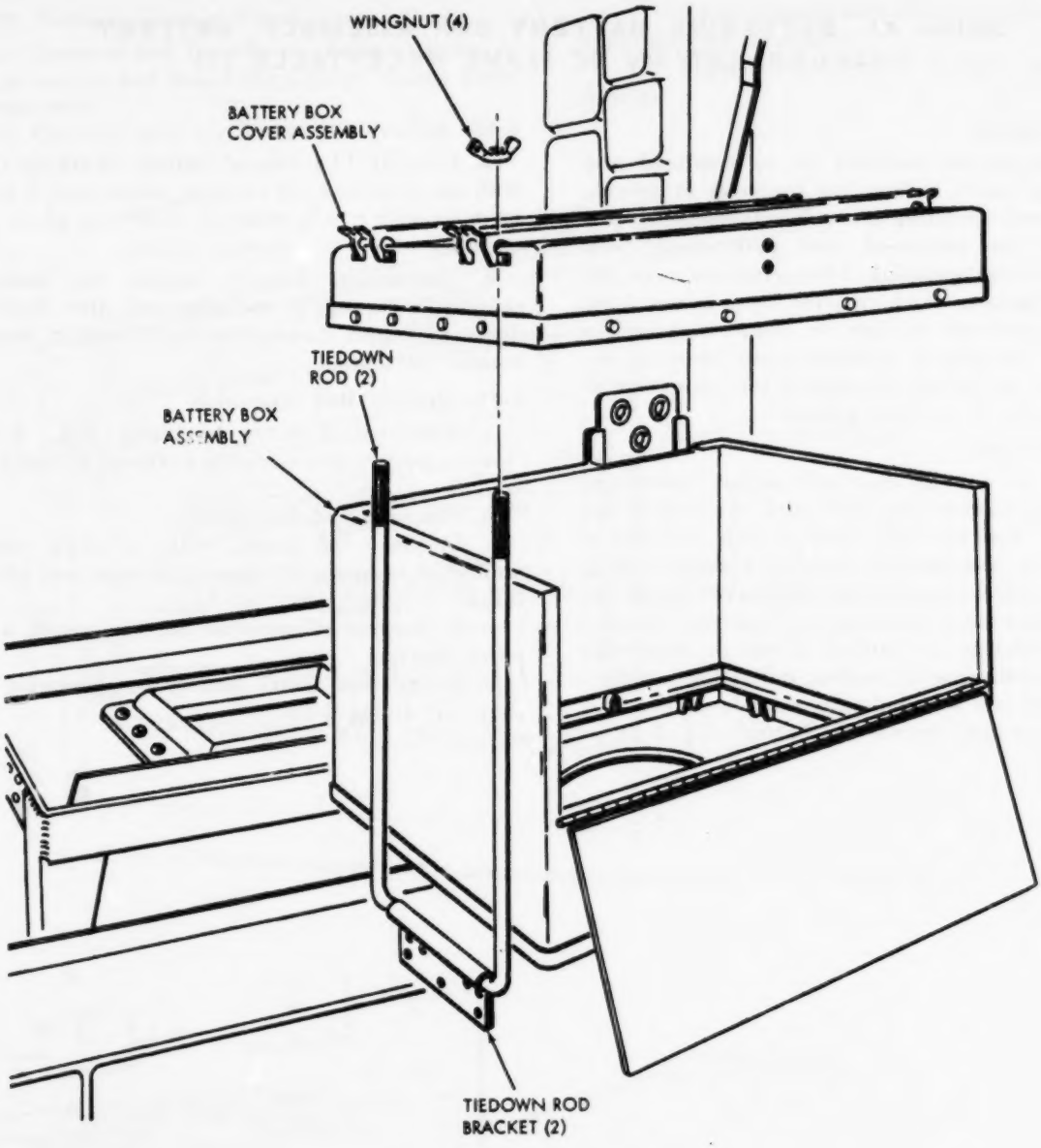
a. Removal. Remove batteries (fig. 2-1). Remove battery box assembly as shown in figure 4-35.

b. Cleaning and Inspection.

(1) Clean all parts with a clean cloth moistened in approved cleaning solvent and allow to dry.

(2) Inspect all parts for cracks, breaks, and other damage.

c. Installation. Install battery box assembly as shown in figure 4-35.



NOTE: TIEDOWN ROD BRACKET IS NORMALLY RIVETED AND IS SHOWN REMOVED ONLY FOR CLARITY.

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Figure 4-35. Battery box assembly, removal and installation.

4-47. 24V DC SLAVE Receptacle J15 and Convenience Receptacle Fuse Holder

a. Removal. Remove 24V DC SLAVE RECEPTACLE J15 and the 400-cycle convenience receptacle fuse holder as shown in figure 4-36.

b. Cleaning and Inspection.

(1) Clean all parts with a clean cloth moistened in approved cleaning solvent and allow to dry.

(2) Inspect parts for cracks and breaks. Inspect connector for signs of arcing and other damage.

c. Installation. Install 24V DC SLAVE

RECEPTACLE J15 and fuse holder as shown in figure 4-36.

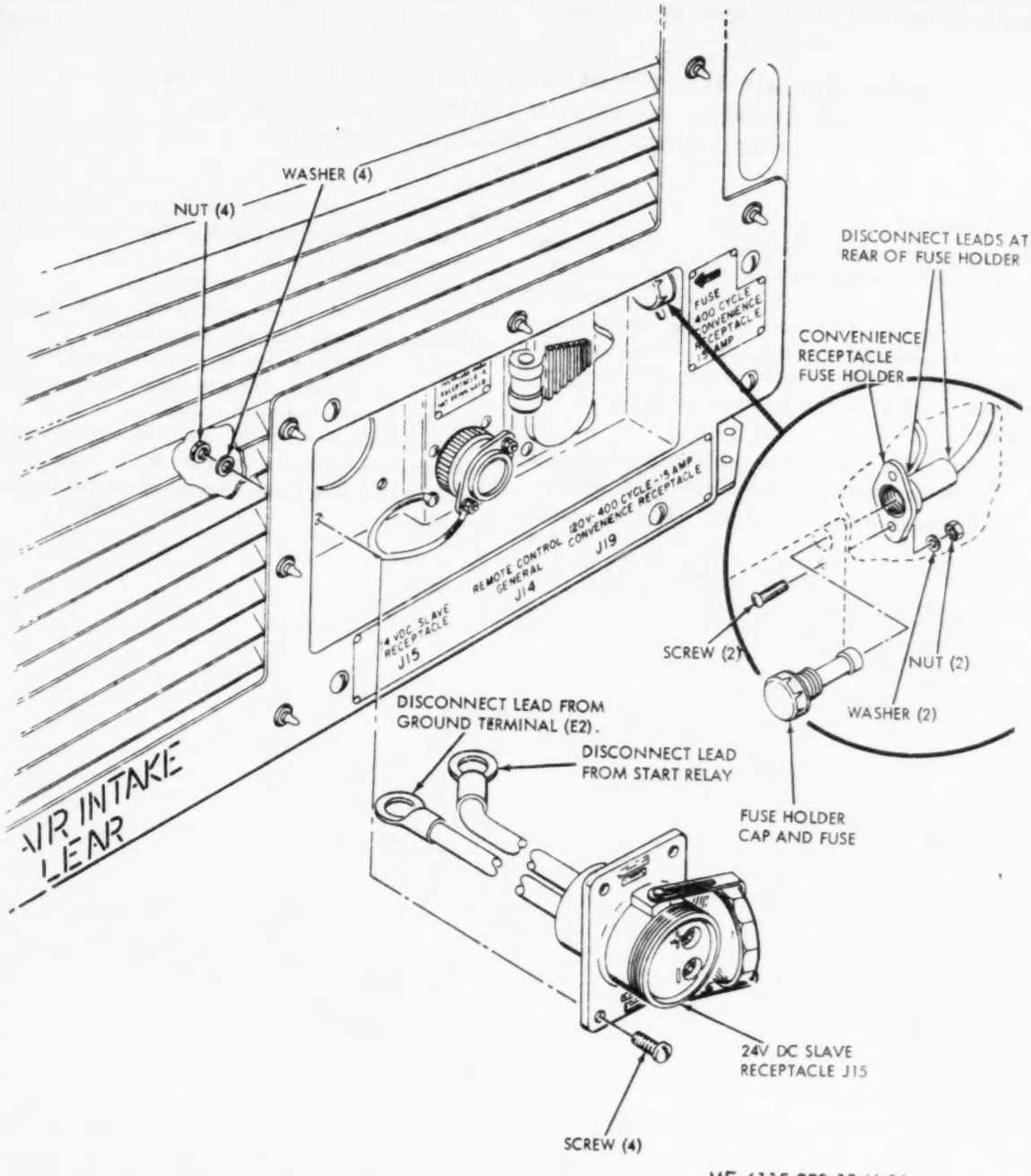
WASHER (4)
NUT (4)
DISCONNECT LEADS AT REAR OF FUSE HOLDER
CONVENIENCE RECEPTACLE FUSE HOLDER
FUSE 400 CYCLE CONVENIENCE RECEPTACLE 15 AMP
REMOTE CONTROL GENERAL J14
120V, 400 CYCLE-15 AMP CONVENIENCE RECEPTACLE J19
24 VDC SLAVE RECEPTACLE J15
SCREW (2)
NUT (2)
WASHER (2)
DISCONNECT LEAD FROM GROUND TERMINAL (E2).
DISCONNECT LEAD FROM START RELAY
FUSE HOLDER CAP AND FUSE
AIR INTAKE LEAR
24V DC SLAVE RECEPTACLE J15
SCREW (4)
ME 6115-339-12/4-36

Figure 4-36. DC Slave receptacle J15 and fuse holder removal and installation.

4-48. Battery Cables

a. General. If battery cables require replacement, fabricate new cables. Cut required length of No. 2 cable, specification MIL-C-5756, and fabricate with terminal lugs as specified below.

b. Positive Battery Cable. Cut cable to 35½ in. and install terminal lugs. Install a red sleeve with each terminal lug.

c. Negative Battery Cable. Cut cable to 48½ in. and install terminal lugs. Install a black sleeve with each terminal lug.

d. Battery Jumper Cable. Cut cable to 3 in. and install terminal lugs.

e. Starter Positive Cable. Cut cable to same length as original cable and install terminal lugs.

f. Starter Negative Cable. Cut cable to same length as original cable and install terminal lugs.

Section XII. AIR INLET SCREEN ASSEMBLY, GENERATOR COOLING AIR EXHAUST HOSES AND CLAMPS, COMBUSTOR CAP, AND COMBUSTION CHAMBER ASSEMBLY

4-49. General

The air inlet screen assembly prevents foreign objects from entering the compressor section. The combustor cap is part of the plenum chamber and partially houses and supports the combustion chamber assembly. The high heat-resistant combustion chamber assembly provides for fuel and air mixing in the combustion area of the engine.

4-50. Air Inlet Screen Assembly and Generator Cooling Air Exhaust Hoses and Clamps

a. Removal. Remove air inlet screen assembly and gaskets as shown in figure 4-37. Remove generator cooling air exhaust hoses and clamps as shown in figure 4-28.

b. Cleaning and Inspection.

(1) Clean screen and hoses with approved cleaning solvent and dry thoroughly.

(2) Inspect screen for breaks, tears, clogging, and other damage. Inspect hoses and clamps for cracks, breaks, and other damage.

c. Installation. Install air inlet screen assembly and gaskets as shown in figure 4-37. Install cooling air exhaust hoses and clamps as shown in figure 4-28.

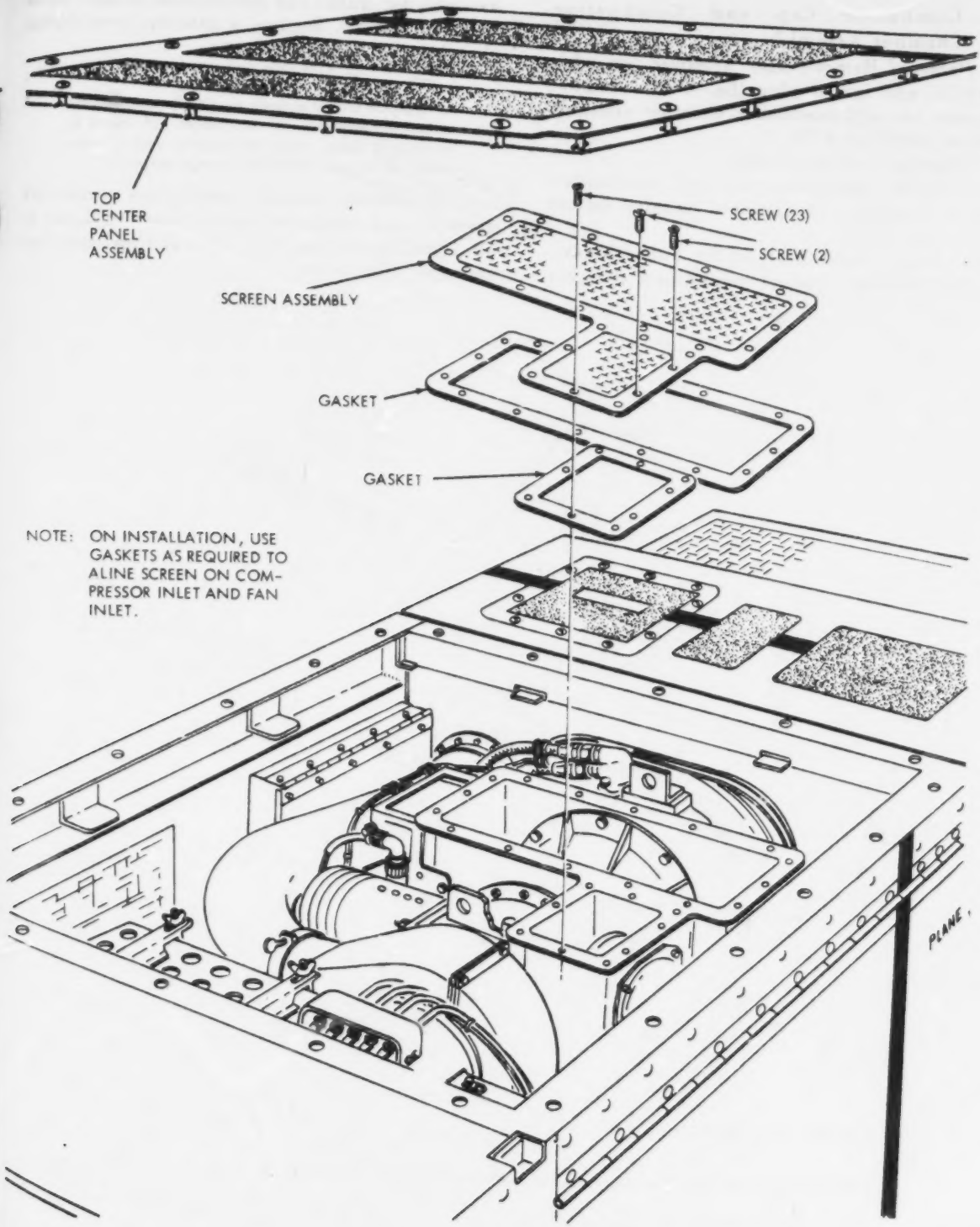

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Figure 4-37. Air inlet screen assembly, removal and installation.

4-51. Combustor Cap and Combustion Chamber Assembly

a. Removal. Remove fuel atomizer assembly (fig. 4-18) and igniter plug (fig. 4-31). Remove combustor cap and combustion chamber assembly as shown in figure 4-38.

b. Cleaning and Inspection.

(1) Clean combustor cap and combustion chamber assembly with approved cleaning solvent and dry thoroughly.

(2) Inspect combustor cap for cracks, breaks, and other damage. Inspect combustion chamber assembly for cracks and deformation in accordance with figure 4-39. Replace a defective combustion chamber.

NOTE

Chipped or eroded ceramic coating on combustion chamber assembly is acceptable. If ceramic coating is flaky, clean thoroughly with a wire brush to remove all loose ceramic material.

c. Installation. Install combustion chamber assembly and combustor cap as shown in figure 4-38. Install igniter plug (fig. 4-31) and fuel atomizer assembly (fig. 4-18).

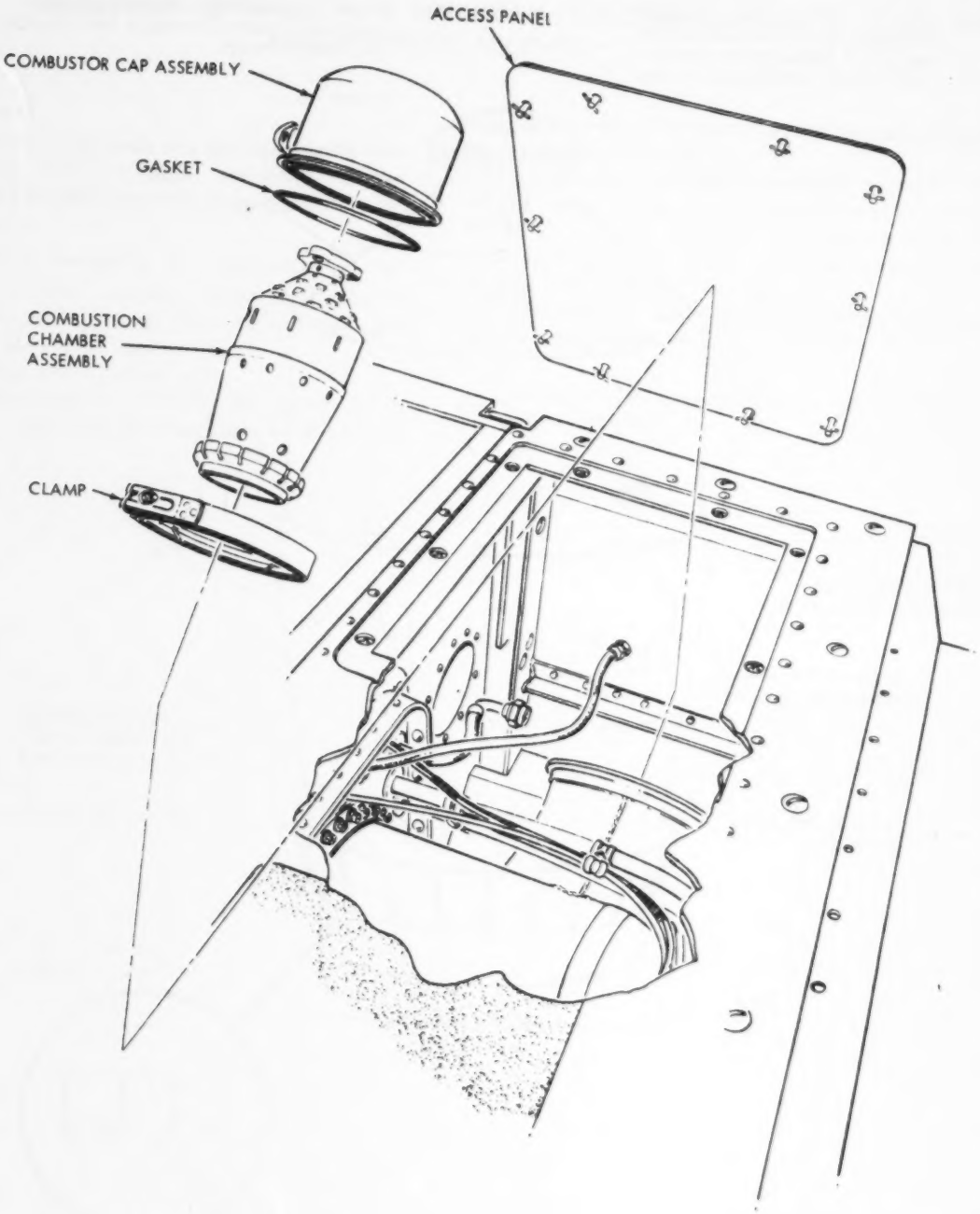
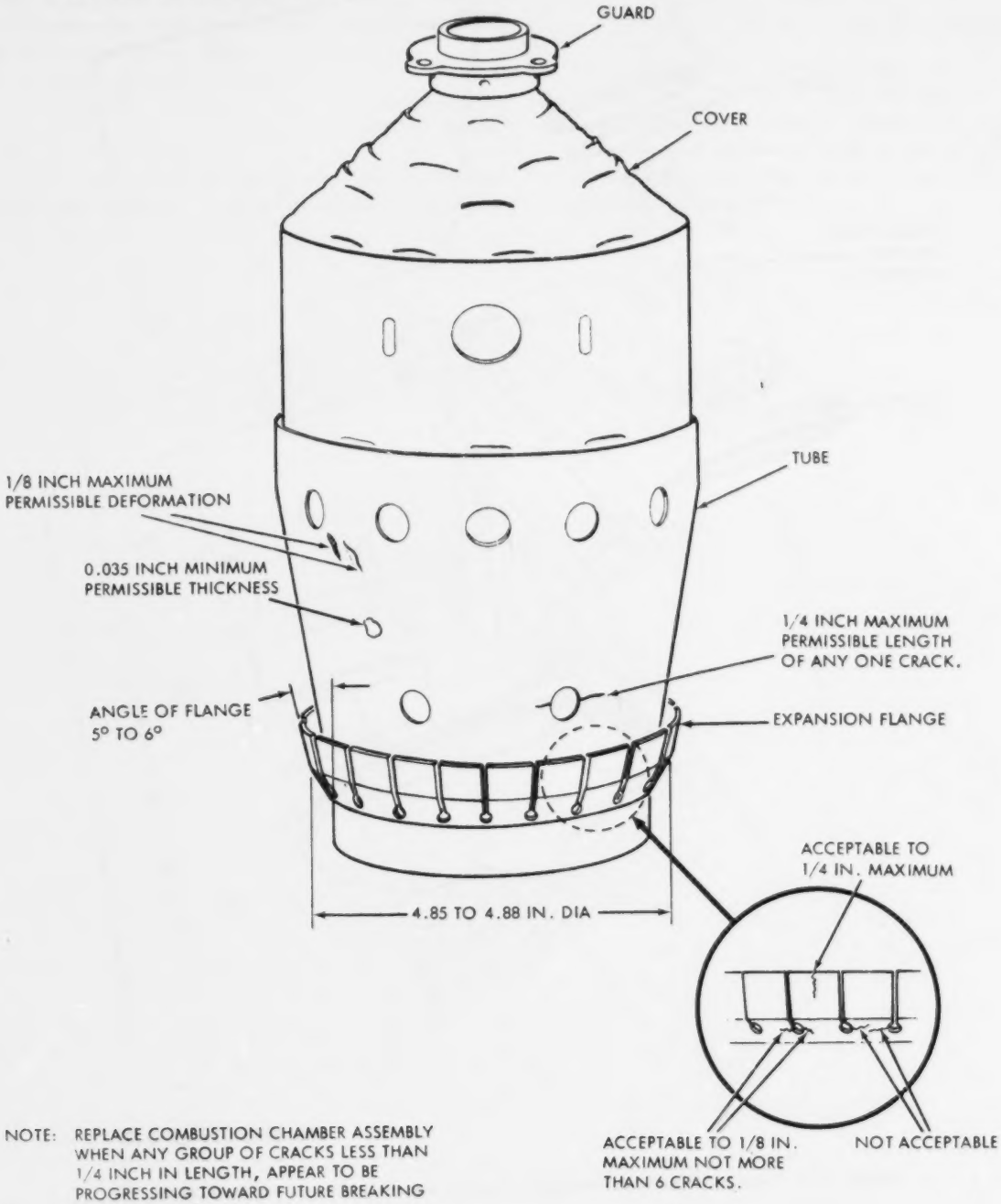


Figure 4-38. Combustor cap and combustion chamber assembly removal and installation.

NOTE: CRACKED TACK WELD AT ATOMIZER ASSEMBLY GUARD SHOULD NOT BE CAUSE FOR REPLACEMENT IF PARTS ARE PROPERLY REWELDED IN PLACE.

NOTE: REPLACE COMBUSTION CHAMBER ASSEMBLY WHEN ANY CRACK CONNECTS TWO OR MORE LOUVERS OR HOLES.


GUARD
COVER
TUBE
1/8 INCH MAXIMUM PERMISSIBLE DEFORMATION
0.035 INCH MINIMUM PERMISSIBLE THICKNESS
1/4 INCH MAXIMUM PERMISSIBLE LENGTH OF ANY ONE CRACK.
ANGLE OF FLANGE 5° TO 6°
EXPANSION FLANGE
4.85 TO 4.88 IN. DIA
ACCEPTABLE TO 1/4 IN. MAXIMUM
ACCEPTABLE TO 1/8 IN. MAXIMUM NOT MORE THAN 6 CRACKS.
NOT ACCEPTABLE

NOTE: REPLACE COMBUSTION CHAMBER ASSEMBLY WHEN ANY GROUP OF CRACKS LESS THAN 1/4 INCH IN LENGTH, APPEAR TO BE PROGRESSING TOWARD FUTURE BREAKING AWAY OF MATERIAL.

ME 6115-339-12/4-39

Figure 4-39. Combustion chamber assembly inspection.

Section XIII. EXHAUST PIPE ASSEMBLY, EJECTOR ASSEMBLY, AND MUFFLER ASSEMBLY

4-52. General

The gases discharged from the turbine engine pass through the exhaust pipe assembly ejector assembly, and muffler assembly before reaching the atmosphere.

4-53. Exhaust Assembly Components

a. Removal. The muffler assembly, exhaust pipe assembly, and the exhaust ejector assembly are removed as shown in figure 4-40.

b. Cleaning and Inspection.

(1) Clean muffler assembly with a clean cloth moistened in approved cleaning solvent (P-D-680) and allow to dry. Dry ejector assembly and exhaust pipe assembly thoroughly.

(2) Inspect muffler assembly screen for breaks, tears, clogging, and other damage. Inspect inside of muffler assembly for deterioration of baffles. Inspect all other parts and exterior of muffler assembly for damage.

c. Installation. Install exhaust pipe, ejector, and muffler assemblies as shown in figure 4-40.

NOTE

Torque exhaust pipe assembly screws between 40 to 60 inch-pounds.

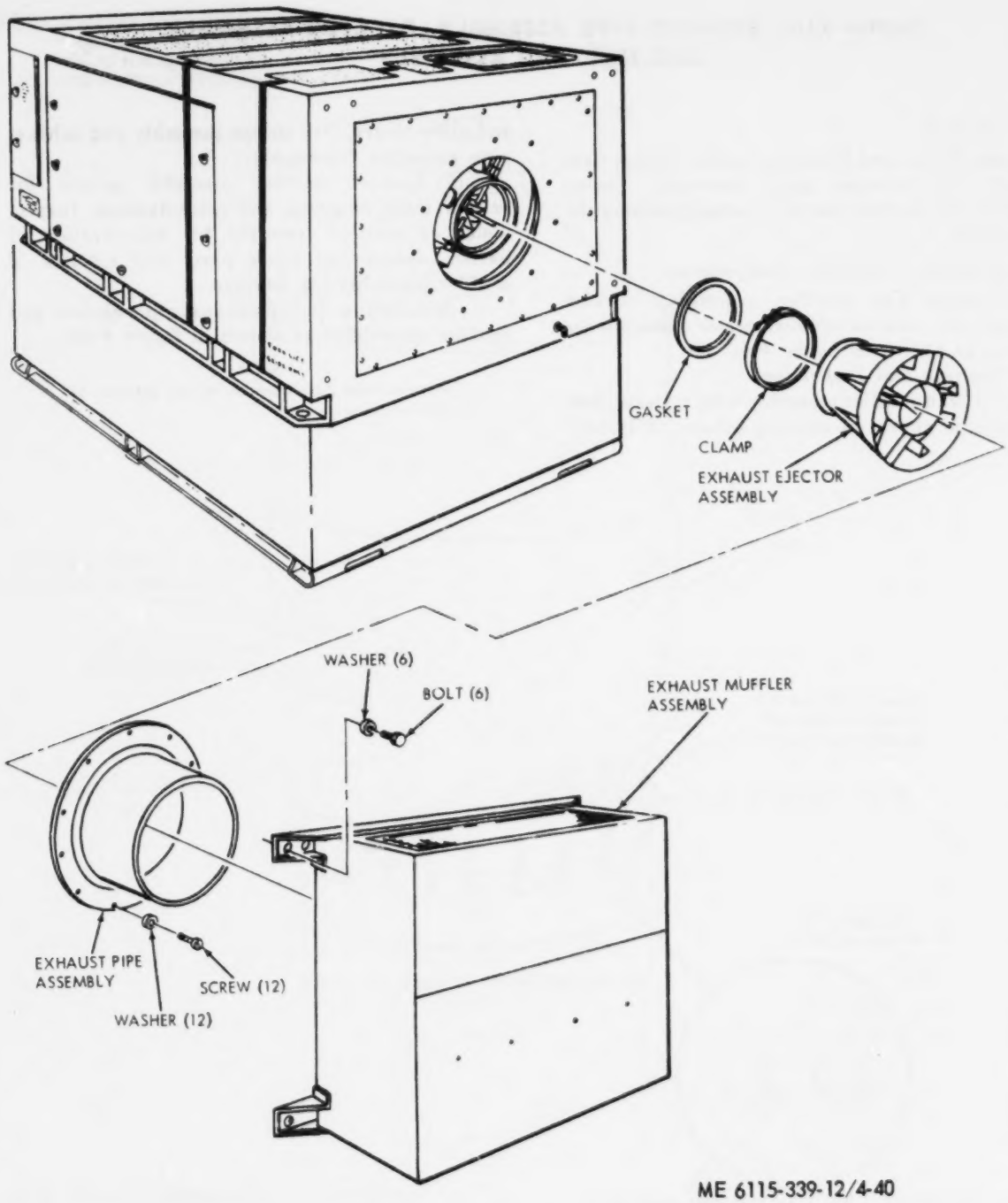


Figure 4-40. Exhaust muffler, ejector, and pipe assemblies, removal and installation.

Section XIV. ENCLOSURE DOORS AND PANELS

4-54. General

The enclosure is a lightweight, sound-absorbing housing for the generator set. It is provided with access doors, and panels for operation and service.

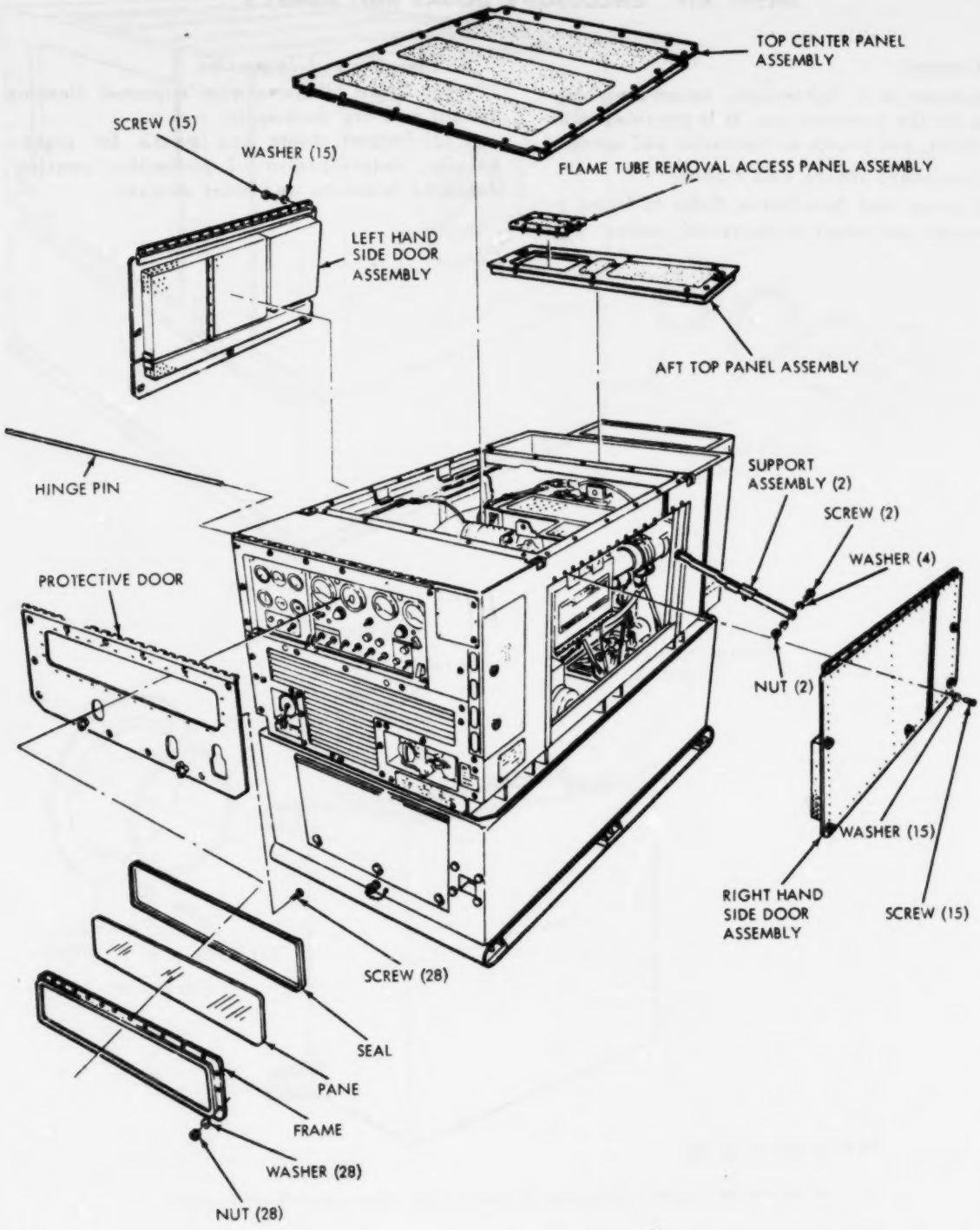
4-55. Enclosure Doors and Panels

a. Removal and Installation. Refer to figure 4-41 to remove and install the doors and panels.

b. Cleaning and Inspection.

(1) Clean all parts with approved cleaning solvent and dry thoroughly.

(2) Inspect doors and panels for cracks, breaks, deterioration of protective coating, damaged fasteners, and other damage.



ME 6115-339-12/4-41

Figure 4-41. Enclosure doors and panels, removal and installation.

Section XV. WINTERIZATION EQUIPMENT

4-56. General

The winterization equipment provides heated air to the battery box assembly during extreme cold weather conditions. The heater is controlled by an electrolyte temperature sensor. The sensor actuates to energize a relay circuit which applies power to the heater pressure regulator valve, fuel pump, igniter and fan motor when the WINTERIZATION HEATER switch on the control panel is in the ON position and the battery electrolyte temperature is approximately 0°F.

4-57. Battery Heater

a. Removal and Installation. Refer to figure 4-42 to remove and install the battery heater.

b. Cleaning and Inspection.

(1) Clean all electrical parts with a clean cloth moistened in approved cleaning solvent and allow to dry. Clean metering orifice.

(2) Inspect all parts for cracks, breaks, and other damage. Inspect receptacle for bent pins and frayed insulation on leads. Inspect resistor assembly for charring and deterioration. Inspect solenoid coil for deterioration and frayed insulation.

c. Adjustment.

(1) Remove cover from heater.

(2) Place WINTERIZATION HEATER switch in ON position.

(3) Rotate adjustment screw on flame switch (fig. 4-43) counterclockwise until the fan operates; turn adjustment screw slowly clockwise until the fan shuts off. Rotate adjustment screw further clockwise onehalf turn from shut off point.

(4) Place WINTERIZATION HEATER switch in OFF position and replace cover on heater.

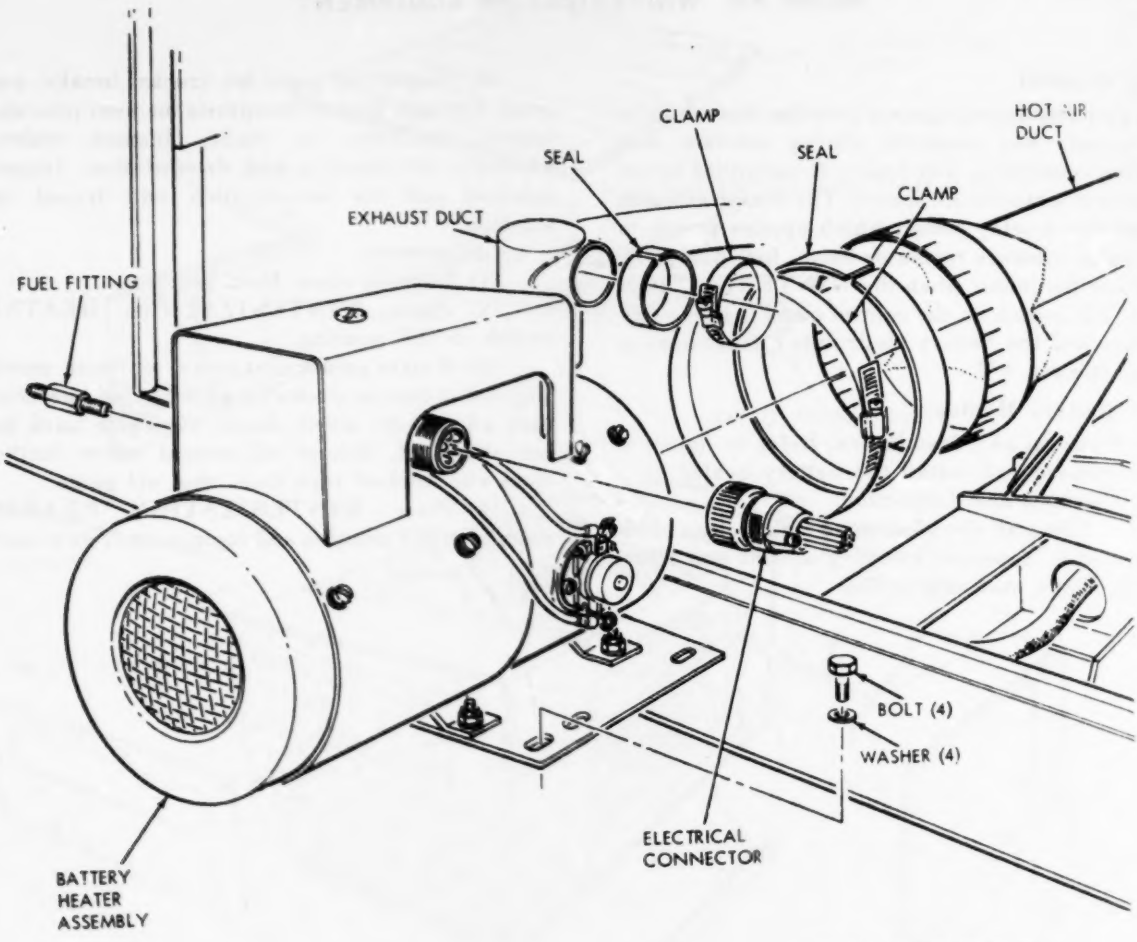
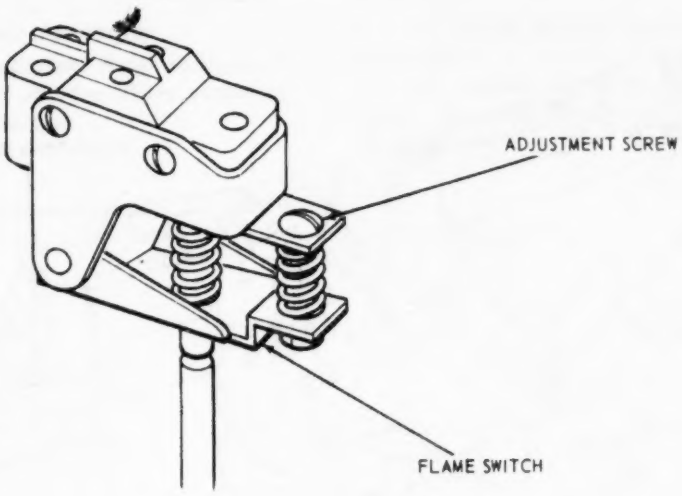


Figure 4-42. Battery heater, removal and installation.



ME 6115-339-12/4-43

Figure 4-43. Flame switch adjustment.

4-58. Heater Fuel Pump

a. Removal and Installation. Refer to figure 4-44 to remove and install the heater fuel pump.

b. Cleaning and Inspection.

(1) Remove cap (fig. 4-44) and clean screen in approved cleaning solvent. Dry thoroughly. Wipe all other parts with a clean cloth moistened in cleaning solvent and allow to dry.

(2) Inspect screen for clogging, breaks, or other damage. Inspect leads for damage to insulation and inspect all other parts for damage.

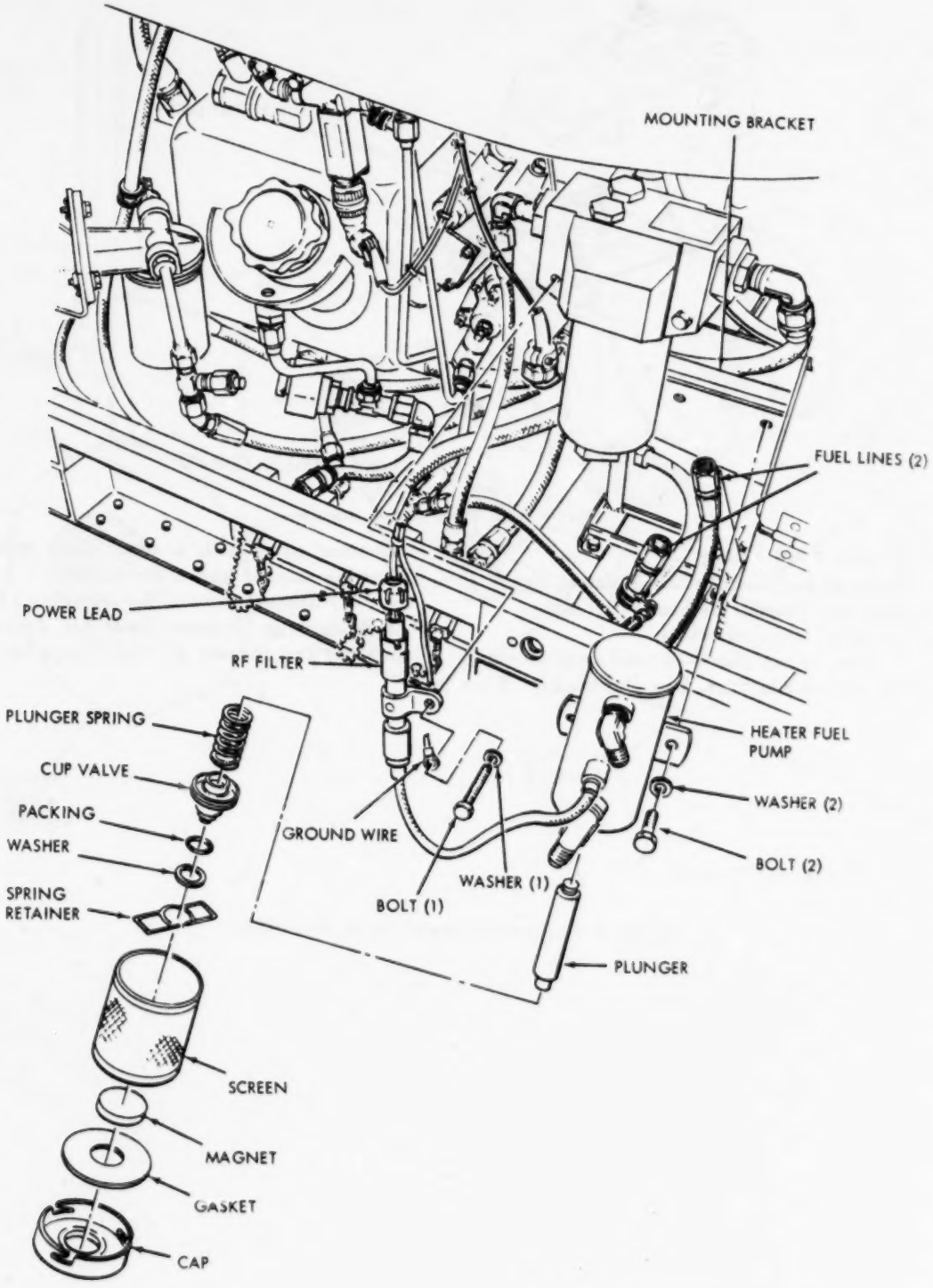


Figure 4-44. Heater fuel pump removal and installation.

4-59. Heater Fuel Filter Assembly

a. Removal and Installation. Refer to figure 4-45 to remove and install the fuel filter assembly.

b. Cleaning and Inspection.

(1) Clean all parts in cleaning solvent and dry thoroughly.

(2) Inspect all parts for cracks, breaks, and other damage. Replace fuel filter element if damaged or clogged.

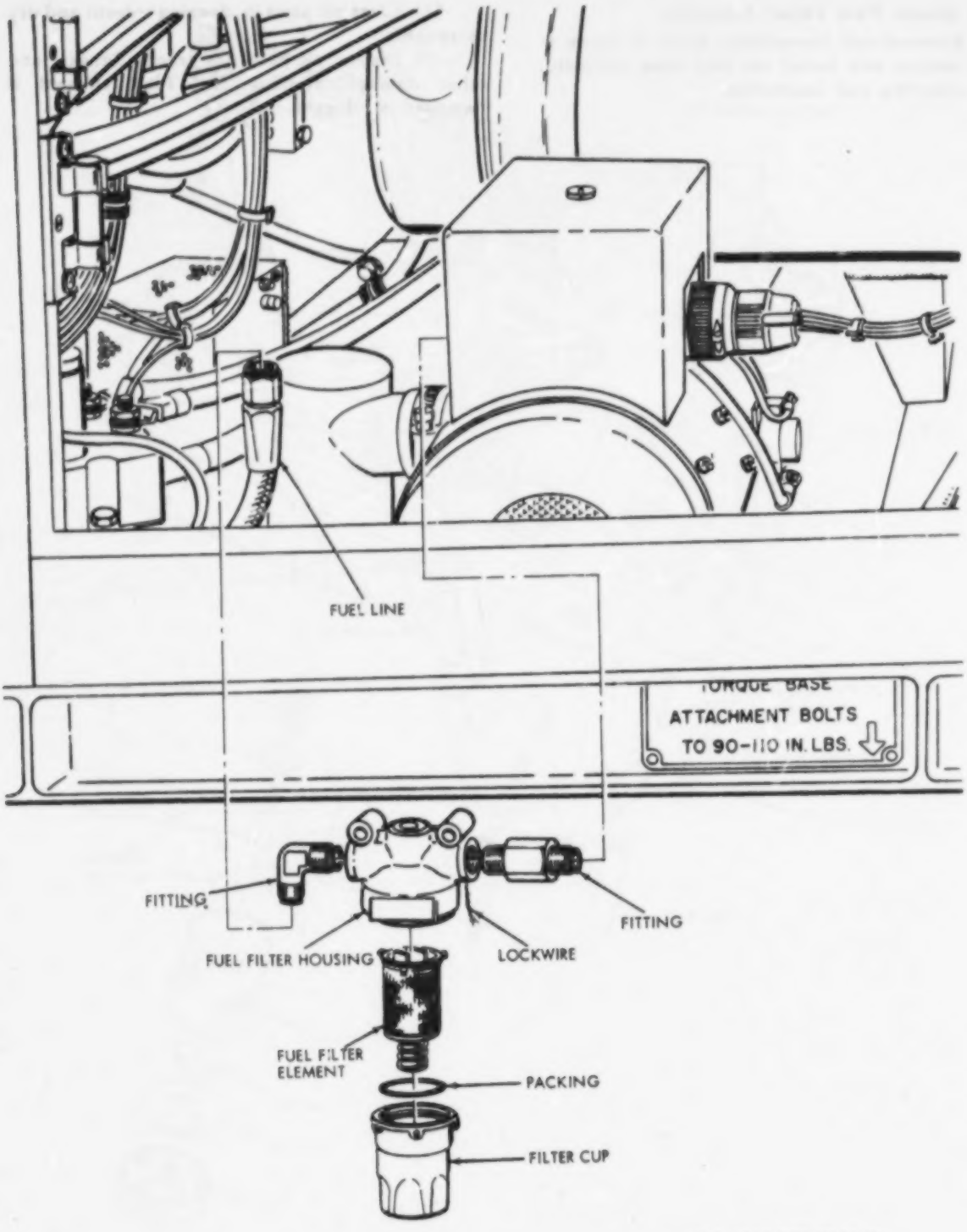


Figure 4-45. Heater fuel filter assembly, removal and installation.

4-60. Heater Fuel Shutoff Valve

a. Removal and Installation. Refer to figure 4-46 to remove and install the heater fuel shutoff valve.

b. Cleaning and Inspection.

(1) Clean all parts in approved cleaning solvent and dry thoroughly.

(2) Inspect all parts for cracks, breaks, and other damage.

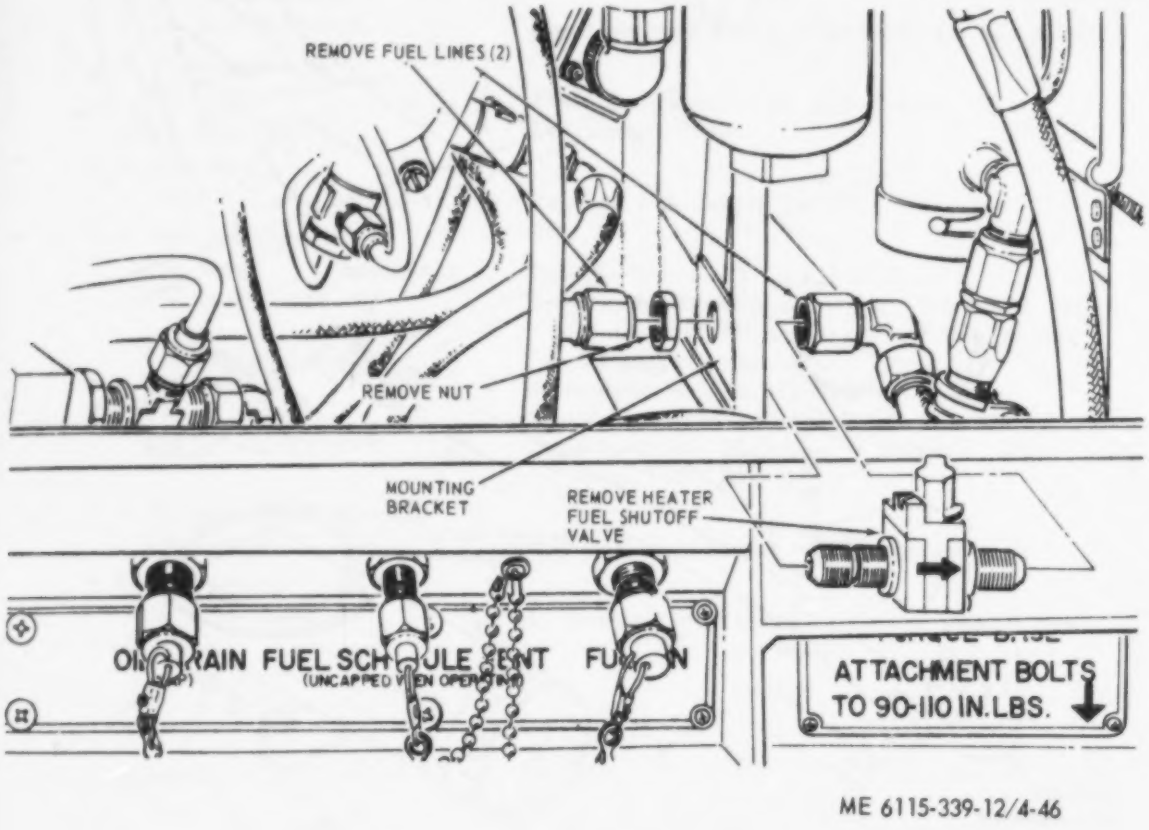


Figure 4-46. Heater fuel shutoff valve, removal and installation.

4-61. Battery Electrolyte Temperature Sensor

Refer to paragraph 2-1 to perform maintenance and servicing of the battery electrolyte temperature sensor.

4-62. Battery Heater Ducting

a. Removal and Installation. Refer to figure 4-47 to remove and install the battery heater ducting.

b. Cleaning and Inspection.

(1) Remove excess dust, dirt, and foreign matter with dry compressed air. Clean ducting in an approved solvent and allow to dry.

(2) Inspect for evidence of damage, corrosion, stripped threads or excessive wear. Replace defective ducting.

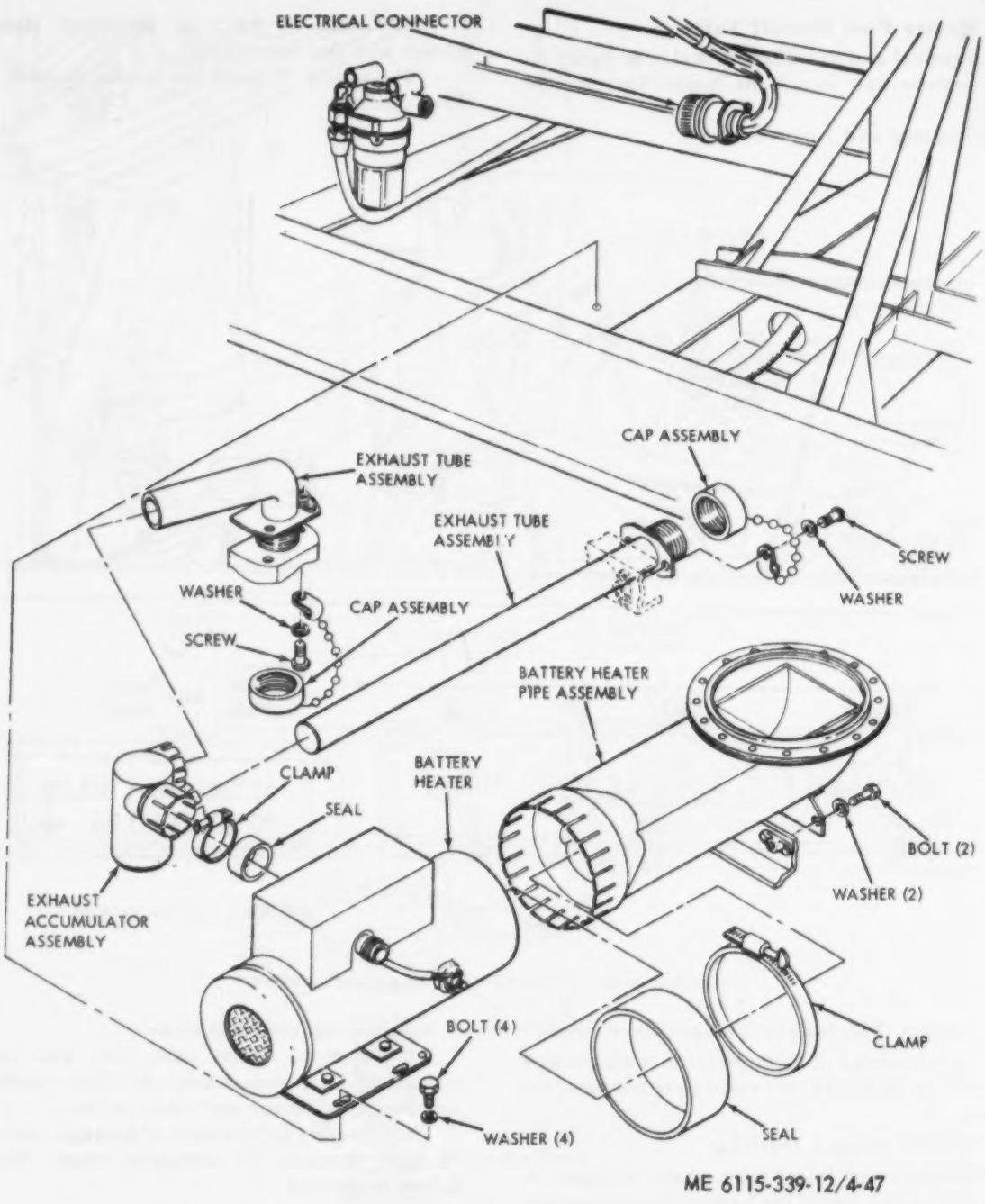


Figure 4-47. Battery heater ducting, removal and installation.

APPENDIX A

REFERENCES

A-1. Fire Protection	
TB 5-4200-200-10	Hand portable Fire Extinguishers for Army Users
A-2. Lubrication	
C9100IL	Fuels, Lubricants, Oils, and Waxes
LO 5-6115-339-12	Lubrication Order
A-3. Painting	
TM 9-213	Painting Instructions for Field Use
A-4. Maintenance	
TM 5-764	Electric Motor and Generator Repair
TM 5-4920-200-15	Operator, Organization, DS, GS, and Depot Maintenance, Engine Analyzer, Gas Turbine
TM 9-6140-200-15	Lead-Acid Type Batteries
TM 38-750	Army Maintenance Management System
TM 11-483	Radio Interference Suppression
TM 5-6115-339-20P	Organizational Maintenance Repair Parts and Special Tools Lists
A-5. Shipment and Storage	
TM 740-90-1	Administrative Storage of Equipment
A-6. Demolition	
TM 750-244-3	Destruction of Materiel to Prevent enemy Use.

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. General

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

b. Section II designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of the maintenance functions upon the end item or component will be consistent with the assigned maintenance functions.

c. Section III lists the special tools and test equipment required for each maintenance function as referenced from section II.

d. Section IV contains supplemental instructions, explanatory notes and / or illustration required for a particular maintenance function.

B-2. Explanation of Columns in Section II

a. Group Number, Column (1). The assembly group is a numerical group assigned to each assembly in a top down breakdown sequence. The applicable assembly groups are listed on the MAC in disassembly sequence beginning with the first assembly removed in a top down disassembly sequence.

b. Assembly Group, Column (2). This column contains a brief description of the components of each assembly group.

c. Maintenance Functions, Column (3). This column lists the various maintenance functions (A through K). The lowest maintenance category authorized to perform these functions are indicated by a symbol in the appropriate column. The symbol designations for the various maintenance categories are as follows:

C—Operator or crew
O—Organizational maintenance
F—Direct support maintenance
H—General support maintenance

The maintenance functions are defined as follows:

A—Inspect. To determine serviceability of an item by comparing its physical, mechanical, and electrical characteristics with established standards.

B—Test. To verify serviceability and to detect electrical or mechanical failure by use of test equipment.

C—Service. To clean, to preserve, to charge, and to add fuel, lubricants, cooling agents, and air. If it is desired that elements, such as painting and lubricating, be defined separately. They may be so listed.

D—Adjust. To rectify to the extent necessary to bring into proper operating range.

E—Align. To adjust specified variable elements of an item to bring to optimum performance.

F—Calibrate. To determine the corrections to be made in the readings of instruments or test equipment used in precise measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared with the certified standard.

G—Install. To set up for use in an operational environment such as an emplacement, site, or vehicle.

H—Replace. To replace unserviceable items with serviceable like items.

I—Repair. Those maintenance operations necessary to restore an item to serviceable condition through correction of material damage or a specific failure. Repair may be accomplished at each category of maintenance.

J—Overhaul. Normally, the highest degree of maintenance performed by the Army in order to minimize time work in process is consistent with quality and economy of operation. It consists of that maintenance necessary to restore an item to completely serviceable condition as prescribed by maintenance standards in technical publications for each item of equipment. Overhaul normally does not return an item to like new, zero mileage, or zero hour condition.

K—Rebuild. The highest degree of materiel maintenance. It consists of restoring equipment as nearly as possible to new condition in accordance with original manufacturing standards. Rebuild is performed only when required by operational considerations or other paramount factors and then only at the depot maintenance category. Rebuild reduces to zero the hours or miles the equipment, or component thereof has been in use.

d. Tools and Equipment, Column (4). This column is provided for referencing by code the special tools and test equipment, (sec. III) required to perform the maintenance functions (sec. II).

e. Remarks, Column (5). This column is provided for referencing by code the remarks (sec. IV) pertinent to the maintenance functions.

B-3. Explanation of Columns in Section III

a. Reference Code. This column consists of a number and a letter separated by a dash. The number references the T&TE Requirements column on the MAC. The letter represents the specific maintenance function the item is to be used with. The letter is representative of columns A through K on the MAC.

b. Maintenance Category. This column shows

the lowest level of maintenance authorized to use the special tool or test equipment.

c. Nomenclature. This column lists the name or identification of the tool or test equipment.

d. Tool Number. This column lists the manufacturer's code and part number, or Federal Stock Number of tools and test equipment.

B-4. Explanation of Columns in Section IV

a. Reference Code. This column consists of two letters separated by a dash, both of which are references to section II. The first letter reference column (5) and the second letter references maintenance function, column (3), A through K.

b. Remarks. This column lists information pertinent to the maintenance function being performed, as indicated on the MAC.

Section II. MAINTENANCE ALLOCATION CHART

(1) Group No.	(2) Assembly group	(3) Maintenance functions											(4) Tools and equipment	(5) Remarks
		A	B	C	D	E	F	G	H	I	J	K		
		Inspect	Test	Service	Adjust	Align	Calibrate	Install	Replace	Repair	Overhaul	Rebuild		
01	BODY, CAB, HOOD AND HULL													
	Enclosure Assembly Panels, Doors and Cover	O							O	F				
02	ENGINE ASSEMBLY													
	Engine	C	F	C					F	O	D		1	A
	Compressor assembly	O							H	D	D		2	
	Plenum assembly, inlet	O							F	F				B
	Cap, combustor	O							O					
	Liner, combustion	O		O					O	F				C
	Plenum, Turbine	O							F	F			3	
	Exhaust, Turbine flange	O							O	F				D
	Muffler Assembly	O							O	F				
	Exhaust pipe assembly and ejector	O							O	F				
	Turbine assembly	O							F	F	D			
	Nozzle Assembly	O			F				D					
	Torus	O							F	F				E
	Accessory Drive Assembly	O							H	F	D		4	F
	Rotating assembly fan	O							F	H				
	Fuel Control	O	F	O	F				F	F	D			G
	Pump Assembly, Fuel Boost	O	F	O	F				O	F	D			
	Filter, Fuel	O		O					O					
	Atomizer Assembly, Fuel	O		O					O	F	D			H
	Valve, fuel solenoid	O	O						O	F				
	Valve, overtemperature by-pass	O	O						O	F				
	Tanks, fuel and auxiliary	O		C					F	H				
	Switches, float and by-pass		F						F					
	Valves, fuel selector	O							O					
	Hoses, lines and fittings	O							O					
	Pump assembly, oil	O	F						F	F	D		5	I
	Filter assembly, oil	O		O					O	O				
	Tank assembly, oil	O		C					F	F				J
	Cooler, oil	O							O	F	D			
	Nozzle and tubes, oil jet	F							F					
	Screens, valves, lines, hoses and duct	O							O	O				
03	ELECTRICAL SYSTEM													
	Starter assembly	O	O		F				O	F	D		6	K
	Relay assembly, holding		F						F					
	Relay, starter	O	O						O	F				
	Igniter plug	O		O					O					L
	Igniter unit	O	O						O					
	Battery, storage	C	O	C					O					
	Wiring, cables and connectors	O	O						F					
	Battery charger	O	F		F				F	F	D			

Section II. MAINTENANCE ALLOCATION CHART

(1) Group No.	(2) Assembly group	(3) Maintenance functions A Inspect	B Test	C Service	D Adjust	E Align	F Calibrate	G Install	H Replace	I Repair	J Overhaul	K Rebuild	(4) Tools and equipment	(5) Remarks
04	ELECTRIC GENERATOR													
	Generator assembly	O	F	..	..	..	..	..	F	F	D	..	..	M
	Rotor assembly	..	F	..	..	..	..	..	F	F	D	..	..	N
	Stator assembly	..	F	..	..	..	..	..	F	F	D	..	..	O
	Ducts, hoses and clamps	O	..	..	..	..	..	..	O					
	Regulator voltage	O	F	..	..	..	..	..	F	F	D			
05	SAFETY CONTROLS													
	Switch assembly, centrifugal	O	F	..	F	..	..	..	F	F	D	..	..	P
	Thermocouple	O	F	..	..	..	..	..	O					
	Thermostat, pneumatic	O	..	..	F	..	..	..	F	..	..	..	..	Q
	Switches, oil pressure	O	O	..	..	..	..	..	O					
	Relays and circuit breakers	O	..	..	..	..	..	..	O					
	Tachometer, generator	O	F	..	..	..	..	..	F					
06	MISCELLANEOUS													
	Engine control panel	O	..	..	..	..	..	..	F	O				
	Instruments and meters	O	..	..	..	..	..	..	O					
	Switches, lamps and fuses	O	..	..	..	..	..	..	O					
	Winterization heater assembly	O	..	..	O	..	..	..	O	F	D			
	Ducts, hoses and clamps	O	..	..	..	..	..	..	O					
	Valves and lines	O	..	..	..	..	..	..	O					
	Battery box	O	..	..	..	..	..	..	O	F				

Section III. SPECIAL TOOL AND SPECIAL TEST EQUIPMENT REQUIREMENTS

Reference code	Maintenance level	Nomenclature	Tool number
1-B	F	Engine analyzer	4920-778-6091
1-B	F	Cable assy special 281683-1	6115-872-7767
1-B	F	Hose kit, analyzer	1450-799-8432
1-H	F	Sling, beam, adjustable	6115-731-0051
2-H	H	Stand, Portable, engine	4920-861-3068
2-H	H	Adapter, engine stand	4920-717-7019
2-H	H	Adapter, engine stand	4920-778-6089
2-H	H	Mount, Lower	281449-2
3-H	F	Wrench, Open end fixed	5120-656-4774
4-I	F	Puller, mechanical fan	5120-330-8527
4-I	H	Holder, seal installing	4920-614-8483
4-I	H	Wrench, spanner	5120-778-6181
4-I	H	Adapter, wrench	5120-608-6794
4-I	H	Adapter, Wrench	5120-608-6794
4-I	H	Driver, Seal	5120-778-6115
4-I	H	Driver, Seal	5100-733-7113
5-I	F	Puller, Mechanical Seal	5120-608-8239
6-D	F	Adapter, Torque Wrench	5120-608-4756
6-D	F	Holder, Clutch torquing	4920-336-0648

Section IV. REMARKS

Reference code	Remarks
A-B	Test for proper functions using engine analyzer test set. Replacement of complete gas turbine assemblies should only be accomplished when a malfunction of a major section cannot be identified. (Accessory, compressor or turbine).
B-I	Minor repair
C-I	Stop drill cracks. Minor welds
C-C	Remove carbon deposits
D-I	Minor weld on exhaust flange
E-I	Minor weld on torus
F-I	Replace external seals only
G-I	Replace input shaft seal only
H-C	Service consists of cleaning screen and atomizer to remove deposits. Replace seals, valves, etc.
I-B	Test oil pump pressure using engine analyzer.
I-I	Replace oil pump shaft seal
J-I	Repair consists of minor welding
K-B	Test for open windings
K-D	Adjust clutch for proper torque
K-H	Replace starter and clutch as an assembly
K-I	Repair consists of removing deposits
L-C	Service consists of removing deposits
M-B	Test for continuity and insulation resistance
N-I	Minor repair
O-I	Minor repair
P-B	Test for proper sequence using analyzer
P-D	Minor adjustment for proper sequence using analyzer
P-I	Repair consist of replacing switch assembly
Q-D	Adjust by adding or removing shims for proper temperature. Add to decrease, remove to increase; .001 thick equals approximately 30° F. temperature change.

APPENDIX C

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

C-1. Scope

This appendix lists items which accompany the generator set or are required for installation, operation, or operator's maintenance. Repair parts and Special Tools assigned maintenance code "C" in the organizational portion of the Maintenance Repair Parts and Special Tools List Manuals, may be stocked at the operator level of maintenance when authorized by the Unit Commander.

C-2. General

The Basic Issue Items List is divided into the following sections:

a. Basic Issue Items—Section II. A list of items which accompany the generator set and are required by the crew / operate for installation, operation, or maintenance.

b. Maintenance and Operating Supplies—Section III. A listing of maintenance and operating supplies required for initial operation.

C-3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Basic Issue Items, section II.

a. Source, Maintenance, and Recoverability Codes (SMR):

(1) Source code indicates the source for the listed item. Source codes are:

Code	*Explanation*
P	Repair parts, special tools and test equipment supplied from the GSA / DSA, or Army supply system and authorized for use at indicated maintenance categories.
P2	Repair parts, Special Tools and Test Equipment which are procured and stocked for insurance purposes because the combat or military essentiality of the end item dictates that a minimum quantity be available in the supply system.
M	Repair parts, Special Tools and Test Equipment which are not procured or stocked, as such, in the supply system but are to be manufactured at indicated maintenance levels.
A	Assemblies which are not procured or stocked as such, but are made up of two or more units. Such component units carry individual stock numbers and descriptions, are procured and stocked separately and can be assembled to form the required assembly at indicated maintenance categories.
X	Parts and assemblies that are not procured or stocked because the failure rate is normally below that of the applicable end item or component. The failure of such part of assembly should result in retirement of the end item from the supply system.
X1	Repair parts which are not procured or stocked. The requirement for such items will be filled by use of the next higher assembly or component.
X2	Repair parts, Special Tools and Test Equipment which are not stocked and have no foreseen mortality. The indicated maintenance category requiring such repair parts will attempt to obtain the parts through cannibalization or salvage, if not obtainable through cannibalization or salvage, the item may be requisitioned with exception data, from the end item manager, for immediate use.
G	Major assemblies that are procured with PEMA funds for initial issue only as exchange assemblies at DSU and GSU level. These assemblies will not be stocked above DS and GS level or returned to depot supply level.

NOTE

Cannibalization or salvage may be used as a source of supply for any items source coded above except those coded X1 and aircraft support items as restricted by AR 700-42.

(2) Maintenance code indicates the lowest category of maintenance authorized to install the listed item. The maintenance level code is:

Code	*Explanation*
C	Crew / operator

(3) Recoverability code indicates whether unserviceable items should be returned for recovery or salvage. Items not coded are nonrecoverable. Recoverability codes are:

Code	*Explanation*
R	Applied to repair parts, (assemblies and components) special tools and test equipment which are considered economically reparable at direct and general support maintenance levels. When the item is no longer economically repairable, it is normally disposed of at the GS level. When supply considerations dictate, some of these repair parts may be listed for automatic return to supply for depot level repair as set forth in AR 710-50. When so listed, they will be replaced by supply on an exchange basis.
S	Repair parts, special tools, test equipment and assemblies which are economically reparable at DSU and GSU activities and which normally are furnished by supply on an exchange basis. When items are determined by a GSU to be uneconomically reparable, they will be evacuated to a depot for evaluation and analysis before final disposition.
T	High dollar value recoverable repair parts, special tools and test equipment which are subject to special handling and are issued on an exchange basis. Such items will be evacuated to the depot

Code	Explanation
	for overhaul or final disposition. Communication-Electronics and Missile Support items will be repaired / overhauled only at depots.
U	Repair parts, special tools and test equipment specifically selected for salvage by reclamation units because of precious metal content, critical materials, high dollar value or reusable casings or castings.

b. Federal Stock Number. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the Federal item name and any additional description of the item required. The abbreviation "w / e", when used as a part of the nomenclature, indicates the Federal stock number, includes all armament, equipment, accessories and repair parts issued with the item. A part number or other reference number is followed by the applicable five-digit Federal supply code for manufacturers in parenthesis. The usable on codes indicate different model and serial number application. Repair parts quantities included in kits, sets, and assemblies are shown in front the repair part name.

d. Unit of Measure (U / M). A two character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. Quantity Incorporated in Unit. This column indicates the quantity of the item used in the assembly group. A "V" appearing in this column in lieu of a quantity indicates that a definite quantity cannot be indicated (e.g. shims, spacers, etc.)

f. Quantity Furnished with Equipment. This column indicates the quantity of an item furnished with the equipment.

g. Illustration. This column is divided as follows:

(1) *Figure number.* Indicates the figu number of the illustration in which the item is shown.

(2) *Item number.* Indicates the callout number used to reference the item in the illustration.

C-4. Explanation of Columns in the Tabular List of Maintenance and Operating Supplies—Section III

a. Component Application. This column identifies the component application of each maintenance or operating supply item.

b. Federal Stock Number. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the item name and brief description.

d. Quantity Required for Initial Operation. This column indicates the quantity of each maintenance or operating supply item required for initial Operation of the equipment.

e. Quantity Required for 8 Hours of Operation. This column indicates the estimated quantities required for an average 8 hours of operation.

f. Notes. This column indicates information notes keyed to data appearing in a preceding column.

Section II. BASIC ISSUE ITEMS

(1) SMR code	(2) Federal stock number	(3) Description Ref No. & Mfr Code — Usable on code	(4) Unit of meas	(5) Qty inc in unit	(6) Qty furn with equip	(7) Illustration (A) Fig No.	(B) Item No.
		GROUP 01—ACCESSORIES	ea	1			
PC	2910-066-1235	ADAPTER, drum	ea	1	1		
PC	7510-889-3494	BINDER, looseleaf	ea	1	1		
PC	7520-559-9618	CASE, operator and maintenance publications	ea	1			
PC	5935-258-9156	CONNECTOR, plug	ea	1			
PC	4210-270-4512	EXTINGUISHER, fire	ea	1	1		
PC	4720-990-7702	HOSE, auxiliary fuel	set	1			
PC		PLUG, ear	set	1			
PC	4240-861-3612	PROTECTOR, aural	ea	1			
PC	5975-878-3791	ROD ASSEMBLY, ground					
		GROUP 02—PUBLICATIONS					
PC		ARMY LUBRICATION ORDER LO-5-6115-339-12			1		
PC		ARMY TECHNICAL MANUAL TM 5-6115-339-12			1		

Section III. MAINTENANCE AND OPERATING SUPPLIES

(1) Component application	(2) Federal stock number	(3) Description	(4) Quantity required F/initial operation	(5) Quantity required F/8 hrs operation	(6) Notes
FUEL TANK		TURBINE FUEL: 55 gal drum as follows:			(1) JP-4 and JP-5 is the preferred fuel
	9130-256-8617 (2)	JP-4 MIL-J-5264	65 gal (1) (3)		(2) See C9100-IL for additional data and requisitioning procedure
	9130-256-1294 (2)	JP-5-MIL-J-5264	65 gal (1) (3)		(3) Tank capacity
		FUEL, GASOLINE: 55 gal drum as follows:			(4) To be used as emergency fuel for limited operation only.
	9130-221-0620 (2)	91A MIL-G-3056	65 gal (3) (4)		(5) See LO for grade application and replenishment intervals
		FUEL, GASOLINE, AVIATION: 55 gal drum as follows:			
	9130-221-0684 (2)	Grade 80/87 MIL-G5572	65 gal (3) (4)		(6) Average fuel consumption for the winterization heater is 0.11 gph for low heat and 0.21 gph for high heat
	9130-221-0674 (2)	Grade 91/96 MIL-G-5572	65 gal (3) (4)		(7) Includes quantity of oil to fill engine system as follows: 4-qt-engine and oil filter
	9130-221-0677 (2)	Grade 100/103 MIL-G-5572	65 gal (3) (4)		
	9130-273-2375 (2)	Grade 115/145 MIL-G-5572	65 gal (3) (4)		
LUBRICATION SYSTEM		OIL, LUBRICATING, TURBINE ENGINE: 1 qt can as follows:			
	9150-782-2627 (7)	LGT MIL-L-7808	4qt	(5)	
WINTERIZATION EQUIPMENT		FUEL: draw from engine supply		(6)	

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W. C. WESTMORELAND,
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Chief of Staff.

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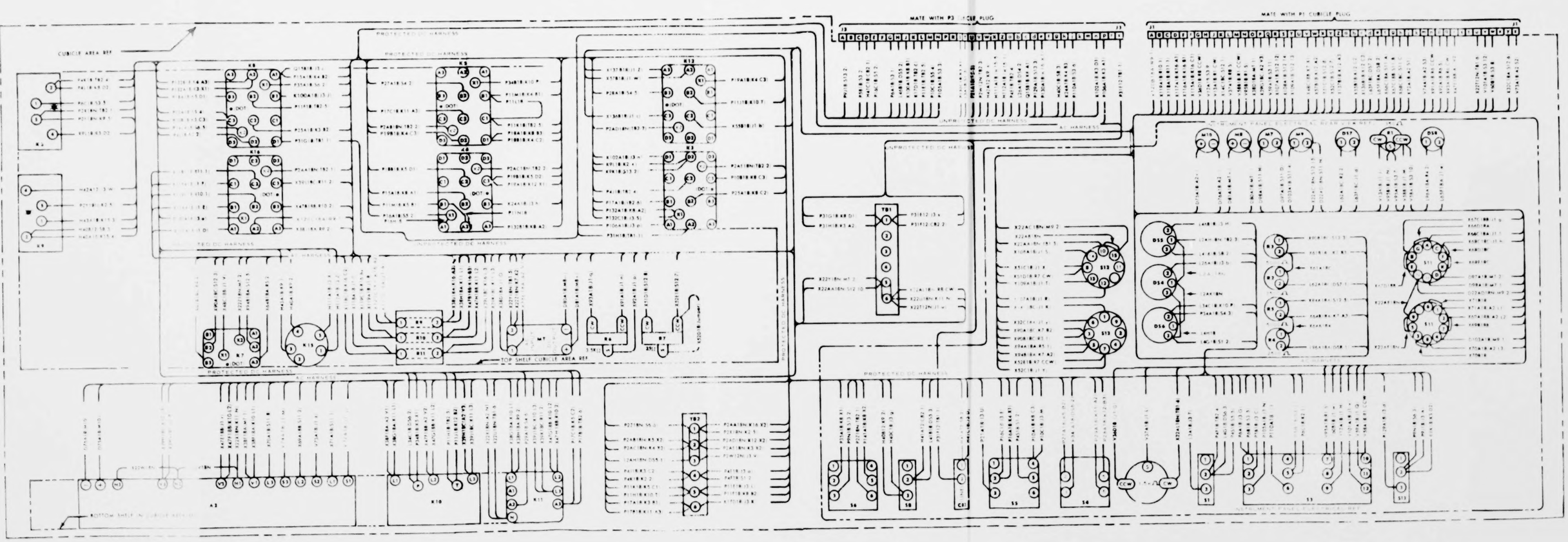
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